ENGINEERING AND MINING JOURNAL

1956

MINING GUIDEBOOK

AND BUYING DIRECTORY ISSUE

MID-JUNE 1956 A McGRAW-HILL PUBLICATION PRICE 50¢

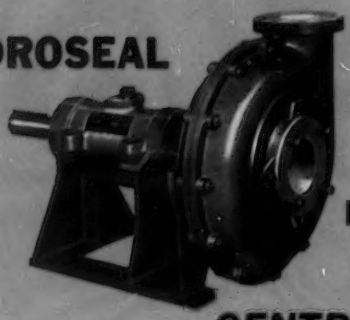
Pump abrasives

. . . efficiently
. . . economically

Slurry for 400 to 8 mesh

INTERCHANGEABLE

HYDROSEAL



Seven Identical Sizes
1½" to 14"
Moulded Maximix Rubber wearing parts

DELIVERS PULP UNDILUTED

CENTRISEAL
(NO SEALING WATER)

Sand for 35 to 4 mesh

HYDROSEAL

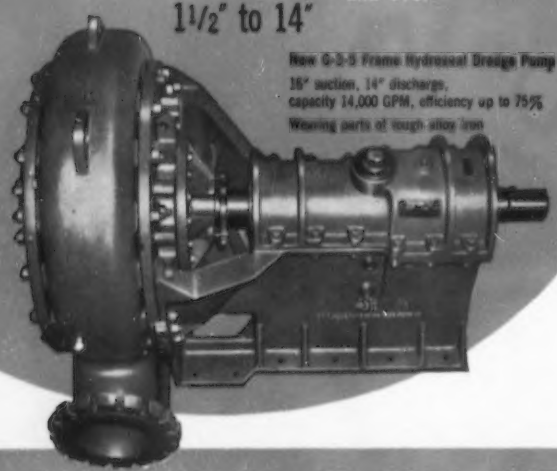
1½" to 12"
Moulded Maximix Rubber wearing parts

HYDROSEAL VERTICAL sump pump

Three Sizes
1½" to 6" suction & discharge
Three Types
Slurry, Sand & Dredge
Moulded Maximix Rubber wearing parts

Dredge for 3 mesh and over

1½" to 14"


New G-3-5 Frame Hydroseal Dredge Pump
16" suction, 14" discharge,
capacity 14,000 GPM, efficiency up to 75%
Wearing parts of tough alloy iron

Since A-S-H pumps give superior performance on jobs to which they are rightly applied, their incomparable range of types and sizes offers you the complete solution to your abrasives-pumping problem. For better handling of materials by pipeline at less cost, draw on the vast experience of our engineers . . . write us about your situation.

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Representatives throughout the World

HYDROSEAL and CENTRISEAL

SAND, SLURRY & DREDGE PUMPS

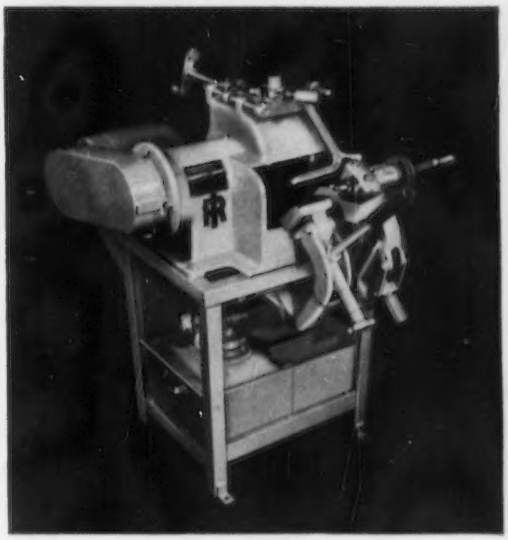
MAXIMIX RUBBER PROTECTED

CARSET JACKBITS

LAST LONGER, DRILL FASTER THAN EVER

...when you keep them sharpened, with machine precision, on the new

JC-3 JACKBIT GRINDER



A NEW Ingersoll-Rand Carset Jackbit has no equal for sustained high drilling speed and maximum bit life in practically any type of rock.

To maintain this "good as new" performance after resharpening, it's important that the cutting faces be ground without unnecessary waste and to the proper shape. Although hand grinding can be used successfully where the number of bits sharpened per day is limited, higher production calls for a *faster* and *more precise* method of resharpening.

These requirements are met to excellent advantage with the new JC-3 Jackbit Grinder. All bit surfaces are ground with machine precision to exactly the right shape for maximum drilling efficiency — more quickly, easily and accurately than can be done by hand grinding.

While the JC Grinder has many new and improved features, it has the same basic design that has proved itself in over 20 years of service. All bearing and wearing surfaces are protected against the entrance of abrasive grits, virtually eliminating bearing maintenance costs. The Jackbit Grinder can be purchased complete with cooling and gauging equipment and electric, air-motor or gasoline-engine drive — or it can be obtained with only that equipment needed for any particular job. To get the *most* out of your Carset Jackbits, ask your I-R representative for complete information on this time-saving, cost-saving Jackbit Grinder.

15-416

FREE WALL CHART: HOW TO GRIND CARSET JACKBITS

Ingersoll-Rand, Rock Drill Dept., 11 Broadway, New York 4

Please send me illustrated wall chart, Form 4121, showing step-by-step instructions for the proper resharpening of Carset Jackbits.

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COMPANY_____

ADDRESS_____

CITY_____ STATE_____

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ROCK DRILLS • COMPRESSORS • AIR TOOLS • CENTRIFUGAL PUMPS • TURBO BLOWERS • CONDENSERS • DIESELS GAS ENGINES

PLASTIC REINFORCED PRIMACORD

Covered with tough plastic material, not affected by high Summer heat or Winter cold. Waterproof—resistant to acids commonly encountered. Use for extremely deep holes, river crossings, field shots that must stand for long periods of time and in other wet conditions. Tensile strength 275 lbs. 1000-ft. spool 22 lbs.

REINFORCED PRIMACORD

Textile reinforced, tough, resilient, flexible. Recommended for surface trunk lines and deep holes where normal strength and resistance to abrasion and cutting are needed. Tensile strength 160 lbs. 1000-ft. spool 18 lbs.

PLAIN PRIMACORD

Textile-covered, flexible and resilient. Suitable for surface trunk lines and shallow holes where tensile strength and resistance to abrasion and cutting are not required. Tensile strength 125 lbs. 1000-ft. spool 17 lbs.

PLASTIC WIRE COUNTERED PRIMACORD

Armored with wire and covered with plastic material. Recommended for use in deep, ragged holes or with metal or fibre explosives containers, where strength and resistance to abrasion and cutting are essential. Tensile strength 300 lbs. 1000-ft. spool 33 lbs.

PRIMACORD® is the registered trade mark brand name of all detonating fuse manufactured by The Ensign-Bickford Company. Controlled laboratory and field testing year after year has resulted in the development of many types of Primacord. For commercial blasting, the four types listed in the table below are recommended for use under the conditions shown:

CONDITIONS	*PRIMACORD RECOMMENDED*			
	Plain	*Reinforced*	*Plastic Wire Countered*	*Plastic Reinforced*
Jackhammer holes	X			
Shallow well-drill holes	X			
Secondary blasting	X			
Deep, ragged holes		X	X	X
Extra deep holes			X	X
Deep, wet holes			X	X
When a field shot must stand a long time			X	X
River Crossings			X	X
Loading with heavily reinforced explosives containers			X	

For your Trunk Line, Plain Primacord serves in most cases. You can use Reinforced Primacord to advantage, especially where the going is rough. **When thunder storms threaten,** or where high voltage cables may release stray electrical currents, always use Primacord. It is not affected by stray currents — and a direct hit by lightning failed to detonate it.

Give Yourself the Best Break...

with PRIMACORD® • QUARRYCORD • IGNITACORD®

QUARRYCORD

Used to connect and ignite safety fuse in secondary blasting. Burns progressively with an external flame at the zone of burning — about one foot per second. Flexible, water-resistant — not affected by stray currents. 500 ft. spools. Quarrycord Connectors — 100 in a box.

IGNITACORD®

Used for connecting and igniting safety fuse in rounds. Burns progressively with a short hot external flame at the zone of burning. Type A, 8 to 10; Type B, 16 to 20 seconds per foot. 100-ft. spools. Ignitacord Connectors — 100 in a box.

For more information see your Explosives Supplier, or write to

The ENSIGN-BICKFORD COMPANY

Simsbury, Connecticut

Primacord • Quarrycord • Ignitacord
Safety Fuse • Blasting Accessories
Established 1836

P-5

ENGINEERING AND MINING JOURNAL MINING GUIDEBOOK

MID-JUNE 1956 Volume 157, No. 6a

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Your 1956 Guidebook

WHAT IT IS. This third annual Mining Guidebook and Buyers' Guide issue was prepared in response to many letters from readers indicating what they needed to know to do a better job of planning exploration, mining, milling and smelting projects. Last year's Guidebook stressed engineering strategy and methods. This year, emphasis is on equipment and services available to the industry. Equipment panoramas, check charts and tables were prepared with the generous help of mining companies, manufacturers and firms offering services to the industry.

HOW TO USE IT. If you're planning a new project, or revamping an old one, scan the numerous types of supplies, equipment and services presented in this issue. After you've narrowed down your choice to types or items which seem most suited to your project, consult the Buyers' Guide p 255 to find out who offers these items or services to the mining industry. A convenient return postage card is enclosed opposite p 286, to aid you in getting data sheets, bulletins and other useful information supplied by companies presenting advertising messages in this issue.

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Member APB and ABC

How Crater keeps wire rope strong longer

One user (name on request) reports on his experience with *Texaco Crater* for the protection of wire rope:

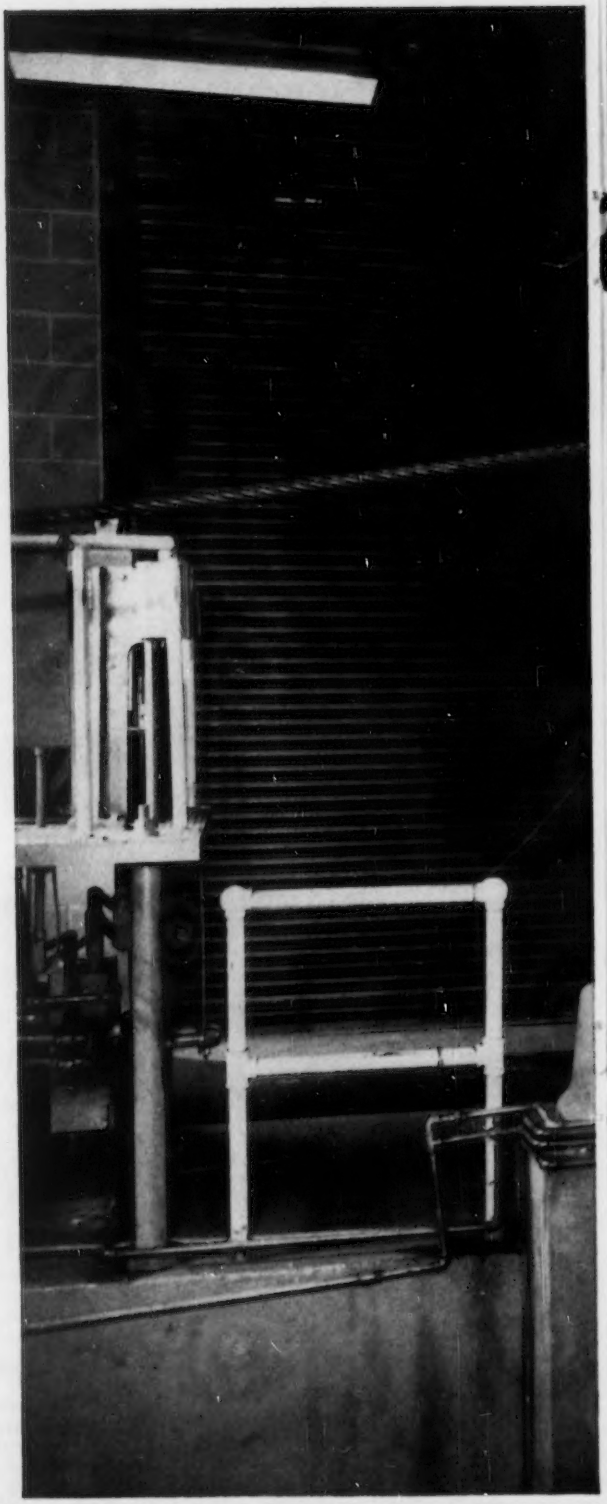
> **"After some two years' service . . . we sent a sample of the rope to the manufacturer for testing. The report on the test showed the rope to be perfectly lubricated and to have more tensile strength than guaranteed when sold to us."**

Texaco Crater keeps rope strong longer because it *penetrates*, gives all-around protection to strands and core. It coats each metal strand with a sturdy, clinging film that fights off wear and rust. It surrounds and protects the rope core, preserving its strength and life.

Many operators like the extra convenience of *Texaco Crater X Fluid*—which *goes* on as a liquid and *stays* on just like the regular *Crater*.

For mine car wheels, use *Texaco Olympian Grease*. It assures easier starts even in winter weather . . . gives long-lasting protection to all types of bearings . . . assures lower maintenance costs.

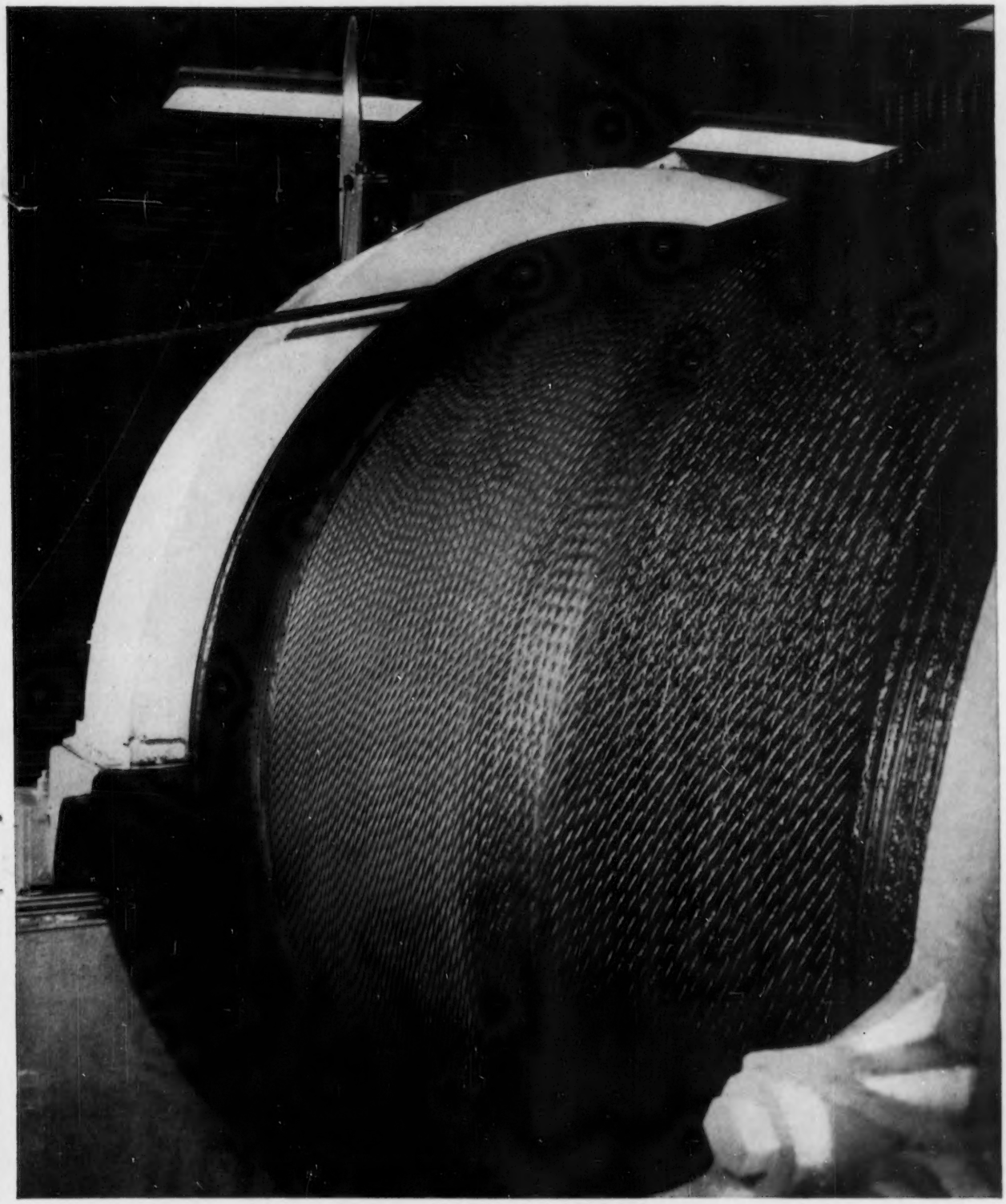
Let a Texaco Lubrication Engineer help you increase efficiency and reduce costs throughout your mine. Just call the nearest of the more than 2,000 Texaco Distributing Plants in the 48 States, or write The Texas Company, 135 East 42nd Street, New York 17, N. Y.



For over 20 years, more copper ore in the U. S. has been mined with Texaco-lubricated equipment than with any other

TUNE IN:
TEXACO STAR THEATER
starring
JIMMY DURANTE
on television . . .
Saturday nights, NBC.

TEXACO



Lubricants and Fuels

FOR THE MINING INDUSTRY

VIBRATING PAN IS THE ANSWER!

Simplicity OS-A-VEYOR feeders lower maintenance and increase operating efficiency . . . LIMESTONE to TACONITE ORE

These Simplicity vibrating pan type feeders have proven themselves throughout the mining and quarry industry. They are not only handling various types of stone and aggregate, but the extremely abrasive taconite ore.

Lower maintenance costs have been proven by long experience in the field. The simplicity of the pan construction allows the unit to be easily repaired with existing materials. These feeders are available with replaceable liners of abrasion resistant steel. The oscillating action is provided by two eccentric shafts coupled to a single V-belt drive . . . leaving only one assembly and four bearings to lubricate.

The Simplicity Os-A-Veyor feeders are self-cleaning units. They experience none of the return spillage found in apron feeders. The Os-A-Veyor feeder will discharge material with a minimum fall, the height of drop is not determined by the size of a sprocket. The units are designed to handle heavy column loads. Overloading the feeders causes no damage, as there is no mechanical connection between the eccentric drive and the main frame or bin.

The Simplicity Os-A-Veyor feeders are main frame supported, or can be supported from the bin with spring and cable suspension, eliminating the need for separate concrete foundation. Sizes available range from 1′ x 4′ to 6′ x 20′ with capacities to 1000 tons per hour.

169

If you wish further information on Simplicity Os-A-Veyor feeders, grizzly feeders, horizontal screens or gyrating screens write . .

SALES REPRESENTATIVES IN ALL PARTS OF THE U.S.A.
FOR CANADA: Simplicity Materials Handling Limited, Guelph, Ontario
FOR EXPORT: Brown and Sites, 50 Church St., New York 7, N. Y.

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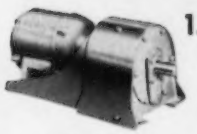
IT PAYS TO *Specify*

FALK

- A wider choice of standard designs
- Practical features exclusive to Falk
- Sound, progressive engineering
- In-built factors for long, efficient service

DRIVES and COUPLINGS

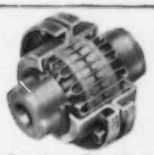


1. Motoreducers All-Motor Horizontal

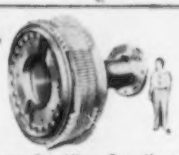
1. Motoreducers All-Motor Right Angle

1. Motoreducers All-Motor Vertical

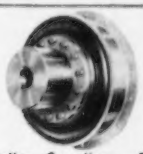
2. Shaft Mounted Drives



3. Steelflex Couplings Standard or Dual Purpose

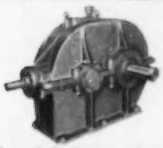


3. Large Steelflex Couplings for Heavy Duty Service

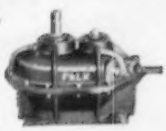


4. Airflex Couplings—For High Torque Fluctuations

5. Speed Reducers Large Parallel Shaft

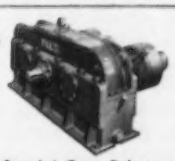


5. Speed Reducers—Large Right Angle Horizontal



5. Speed Reducers—Large Right Angle Vertical

6. High Speed Gear Drives, Reducers or Increasers



7. Special Gear Drives for Any Application

7. Marine Propulsion Gears, Turbine or Diesel Driven

8. Helical Gears—Any Size

You can rely on Falk for top quality engineering and craftsmanship. For more than half a century, Falk engineers and production men have specialized exclusively in the design and manufacture of quality drives and couplings. This accumulation of experience and continuous research has produced a line of products noted for mechanical efficiency, long life, and progressive, practical design . . . products which have earned for Falk a good name in industry throughout the world.

1. **Motoreducers** . . . The famous All-Motor Motoreducer uses any standard foot-mounted motor within the capacity of the gear unit. All-steel construction; helical gearing. Horsepower range from 1 through 75 hp. Output speeds: concentric shaft design — from 1.8 to 580 rpm; right angle shaft design — from 1.2 to 350 rpm. Ratios up to 54,000:1 in special units. Integral design also available, from 1 through 40 hp.
2. **Shaft Mounted Drives** . . . A variation of the Motoreducer design, adapted for mounting on shaft to be driven, using V-belt connection to motor. All-steel construction, helical gearing. Single or double reduction units in six sizes. Horsepower range from 1 through 30 hp. Output speeds from 420 to 10 rpm. Offset shaft design provides means for adjusting belt tension by using turnbuckle on tie-rod.
3. **Steelflex Couplings** . . . Exclusive grid-groove design smothers shock and vibration, accommodates reasonable degrees of shaft misalignment and free end float. The basic Type F is applicable to more than ninety per cent of all industrial applications, horizontal or vertical. Thirty-three sizes to cover capacities from 2/5 through 70,000 hp per 100 rpm (basic rating). Special or dual purpose Steelflex designs available for problem applications. Almost a million Steelflex couplings have gone into industrial service.
4. **Airflex Couplings** . . . Protect machinery against damage from impacts resulting from irregular torque characteristics of prime mover or driven machine. Require no maintenance. Provide electrical insulation between machines. Dual purpose types for problem applications.
5. **Speed Reducers** . . . Falk precision cut helical or spiral bevel gears produce highest attainable mechanical efficiencies. Sturdy housings, liberal bearing capacities, positive lubrication. ***Concentric Shaft Reducers:*** from 1 through 150 hp; ratios from 1.5:1 to 970:1. ***Parallel Shaft Reducers:*** from 15 through 3000 hp; ratios from 2:1 to 300:1; sleeve or roller bearing units. ***Small Right Angle Reducers:*** horizontal or vertical output shaft; from 1 through 150 hp; ratios from 5:1 to 1450:1. ***Large Right Angle Reducers:*** with horizontal output shaft — from 15 through 1000 hp, with ratios from 1.5:1 to 515:1; with vertical output shaft (up or down) — from 15 through 700 hp with ratios from 6:1 to 430:1.
6. **High Speed Drives** . . . For use as reducers or increasers. Quiet operation, high efficiency. Standard units: horsepower range through 5000 hp; maximum speeds ranging from 4500 to 9000 rpm. Special designs: horsepower ratings through 21,500 hp and higher; output speeds above 50,000 rpm, if required.
7. **Special Gear Drives** . . . Falk engineering experience and complete production facilities have designed and produced gear drives for almost any application . . . from sturdy, slow speed mill drives . . . to large marine propulsion drives . . . to ultra high speed drives.
8. **Single Helical or Herringbone Gears** . . . For any application. Hub gears, ring gears, mill pinions. Precision cut, Falk improved tooth form. Face widths up to 6 ft or more. Diameters up to 18 ft. Gears made of Falk alloy steels; pinions made from steel forgings. Full load efficiency of 98% per train.

THE FALK CORPORATION

3049 W. Canal Street, Milwaukee 1, Wisconsin

REPRESENTATIVES AND DISTRIBUTORS IN MOST PRINCIPAL CITIES

ELECTRO-MAGNETIC PULLEY

Powerful Stearns electro-magnetic pulley effectively removes tramp iron from fast-flowing, heavily loaded conveyor lines. Solidly built, thoroughly insulated and protected. Special, new thin-coat drum lagging increases tractive effort without affecting magnetic pull. Sizes range from 12-inch diameter units to world's largest. Bulletin 303-D.

MAGNETIC EQUIPMENT

tailored to the mining industry

Stearns Magnetic, Inc. builds a complete line of magnetic separation equipment to meet the specific requirements of both metallic and non-metallic mining operations. Equipment includes electro-magnetic pulleys, heavy media separators, cross-belt separators, suspended separation magnets, as well as special high-intensity magnetic equipment designed especially for mineral separation.

Stearns' experienced engineers work directly with you in designing and installing magnetic equipment that is engineered to fit your individual operating needs exactly.

In addition, the company maintains a fully-equipped laboratory for thoroughly analyzing and testing ore samples. Requests for analysis or information receive immediate attention. We welcome your inquiry.

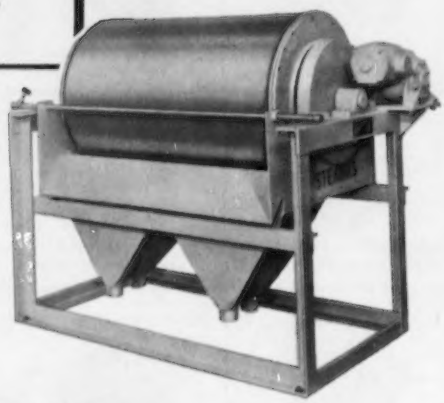
SUSPENDED SEPARATION MAGNET

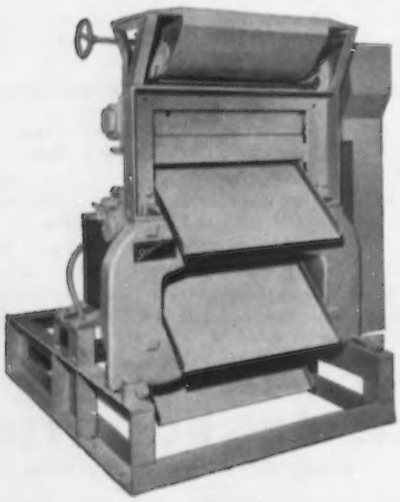
Provides a tremendous pulling force that reaches far down into material on conveyor lines — prevents escape of deeply embedded tramp iron. Coil-wound for continuous duty. Special insulation and rib-type head casting assures fast heat dissipation. Round or rectangular construction. Bulletin 88.

WET-DRUM SEPARATOR FOR TACONITE CONCENTRATION

The new Stearns Type WPD magnetic separator is a powerful wet-drum permanent magnet unit designed for cobbing and roughing in taconite concentrations.

Specially designed magnet has a deep, powerful field, and provides correct flux distribution for positive transport of the collected magnetics to the discharge point. These and many other special features put the WPD separator in a class by itself for fast, low-cost taconite recovery. Bulletin 87.





TYPE K HIGH-INTENSITY GRAVITY INDUCTION MAGNETIC SEPARATOR

Stearns Type K magnetic separator provides an intensely powerful magnetic field which attracts very feebly magnetic particles. That is why the "K" has proved highly successful in purifying and concentrating chemical products when other methods were either impractical or inadequate.

Users report that this separator has given outstanding results for magnetically cleaning or concentrating materials ranging in size from 10 to 200 mesh. Capacity ranges from 80 to over 500 lb per hr per inch of feed width. "K" separators are built in 10, 20 and 30-in. feed widths and can be furnished from 2 to 7 magnetic fields. Bulletin 701B.

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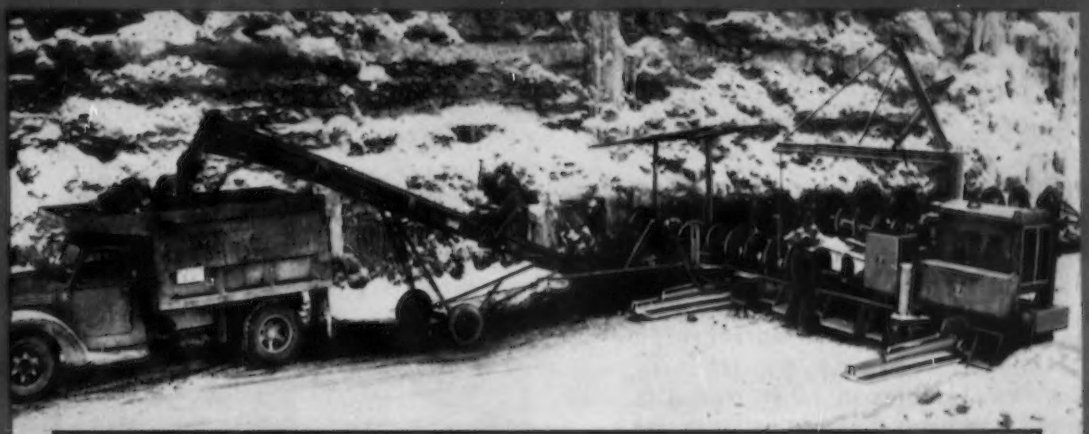
MAGNETIC EQUIPMENT FOR ALL INDUSTRY

STEARNS MAGNETS

Stearns Magnetic, Inc. • 624 S. 28th St., Milwaukee 46, Wis.



McCARTHY AUGER DRILLS

- 60 TO 75 TONS PER HOUR
- SELF-MOVING FROM HOLE TO HOLE
- 2- OR 3-MAN CREW
- MINES HIGH-QUALITY COAL

● Twelve models of McCarthy Coal Recovery Drills auger-mine bonus coal at THE LOWEST operating cost per ton. They operate easily in narrow strip pits. Hydraulic controls simplify alignment, augering and changing position. Let us recommend the right cost-saving model for your property. Write for Bulletin M-101 and M-102.

SELF-PROPELLED

Horizontal Earth and Rock Boring Auger Drills 150 ft. Drilling Depth

● The self-propelled unit permits speedy, economical blast-hole drilling from hole to hole. It takes just a few seconds to disengage the power unit from the auger drive shaft, change position, and begin drilling again. The unit is easily attached to the McCarthy truck-mounted earth and rock boring drills now in use.

TRUCK-MOUNTED

● Truck-mounted horizontal drills are highly versatile. The drilling unit mounts lengthwise or crosswise on the truck bed for spotting hole locations faster. Drilling height from the ground ranges from 4½ to 7 ft. Four separately operated levelling jacks permit close alignment. Write for Bulletin M-105.

HEAVY-DUTY VERTICAL

Model 106-24—World's Fastest Heavy-Duty Vertical Auger Drill

● Bores vertical blast holes faster than any other auger drill. New gear reduction permits slower auger rotation for drilling larger holes deeper in harder rock formations. Augers 8" and 9" dia. drill holes to depths of 125 ft. for use of new type explosives. Controls can be placed at rear and auger racks can be furnished if desired. Write for Bulletin M-100.

FINGER-TIP CONTROL

Gives Desired Rotating Speed Of Auger

HEAVY RUGGED

HYDRAULIC FEED

Provides Any Speed Up To 8 Feet Per Minute Horizontal Feed Of Drill

POWERFUL

MANUFACTURED BY

THE SALEM TOOL COMPANY

803 SOUTH ELLSWORTH AVE. • SALEM, OHIO, U. S. A.

SALEM

DIAMOND BITS and CORE BARRELS

Trouble-free operation—minimum maintenance—maximum core recovery. This is what you buy in Christensen coring equipment. Equipment designed for every type operation and every size drill, from portable to heavy duty types.

SERIES D — Core Barrel

Manufactured in AX, BX, NX, size. This barrel comes in 10 ft. and 5 ft. lengths and takes a core ranging in size from 1.136″ dia. (AX) to 2.060″ dia. (NX). With a full floating inner tube to prevent friction grinding and minimize core wash, this barrel will recover the greatest possible amount of core even in the softer, more fractured formations. Excellent for use with lighter to intermediate weight drills.

SERIES C-2 — Core Barrel

Increased annulus between tubes, between outer tube and hole allows this barrel to be used with either water or oil base mud.

Manufactured with heavy wall tubing, this barrel is recommended for the most severe conditions. The series C-2 barrel is available in AX to NX size; comes in 20, 10, and 5 ft. lengths.*

Core size from 1.067″ dia. (AX) to 1.875″ dia. (NX). NX size is illustrated.

***AX comes in 10 and 5 ft. lengths only.**

3½″ x 2⅛″ Core Barrel

This barrel, similar to our Series 25OP oil field barrels, is made for use with heavy duty drills. It can be used with water, mud, or air, and takes a 2⅛″ core. Available in 20, 15, 10, or 5 ft. lengths.

SERIES D

SERIES C-2 NX SIZE

3½″ x 2⅛″

For complete prices and sizes on all Christensen Diamond Bits and Core Barrels, write for catalog SD-506.

Less cost per foot . . .

FOR MINING EXPLORATION

Rock differs in drillability from area to area. Although any Christensen bit will perform in any formation, you'll get optimum performance from Christensen bits designed to cut a specific type of rock. The variety of types, means there's a Christensen Bit designed to cut the rock you're drilling at "Less Cost Per Foot." Contact us.

CORE BIT — Type 7728

This bit is designed for use with air or mud on Christensen NXC-2 core barrel. Has six waterways, hard matrix, and 48 carats of 3 per carat size diamonds. The oversize O.D. is recommended for air circulation or for use with mud.

CORE BIT — Type 7785

This bit has been used very successfully, using compressed air or mud in drilling sandstone and shale. Has 16 waterways, 60 carats of 4 per carat size diamonds in a hard matrix. Fits Christensen 3½" x 2⅛" core barrel.

CORE BIT — Type 4746

AX series D Face Discharge Coring Bit, 4 ports, no waterways, extra hard matrix, 25 per carat diamonds, about 11.5 carats. Recommended for maximum core recovery in broken and severely abrasive rock. May be made with waterways and discharge ports.

CORE BIT — Type 429

EX Bevel Wall Core Bit, 2 waterways, 40 per carat diamonds, regular matrix, maximum diamond exposure. This bit is set with small diamonds and is recommended for non-abrasive formation, when sludge removal is imperative.

CORE BIT — Type 1720

AX Bevel Wall Core Bit, hard matrix, 25 per carat diamonds, no waterways, approximately 12.5 carats, used for moderately abrasive rocks, where rock is free cutting, and where maximum diamond concentration is desired.

Christensen Diamond Products also manufacture casing shoes, casing bits, reaming shells, and drilling bits. For complete information, write for catalog SD506.

1937 SOUTH SECOND WEST

SALT LAKE CITY 10, UTAH

CHRISTENSEN DIAMOND PRODUCTS

LESS COST PER FOOT CHRISTENSEN DIAMOND PRODUCTS

LINK-BELT PRE-BILT

MADE NEAR YOU

Built in standard sections for 18, 24, 30 and 36-in. belt widths... at each of 9 plants

AN unmatched combination of belt conveyor efficiency and economy, Link-Belt PRE-BILT sectional belt conveyors incorporate standard products packaged with standardized sectional truss frames and structural steel supporting bents. They're easy to install . . . require little or no special engineering on most jobs. And their portability plus easy extension are important aids to flexibility.

PRE-BILT conveyors are manufactured at a Link-Belt plant in your own area to assure prompt delivery. There are also Link-Belt sales offices located throughout the country . . . equipped to give you prompt, efficient service for all your belt conveyor requirements.

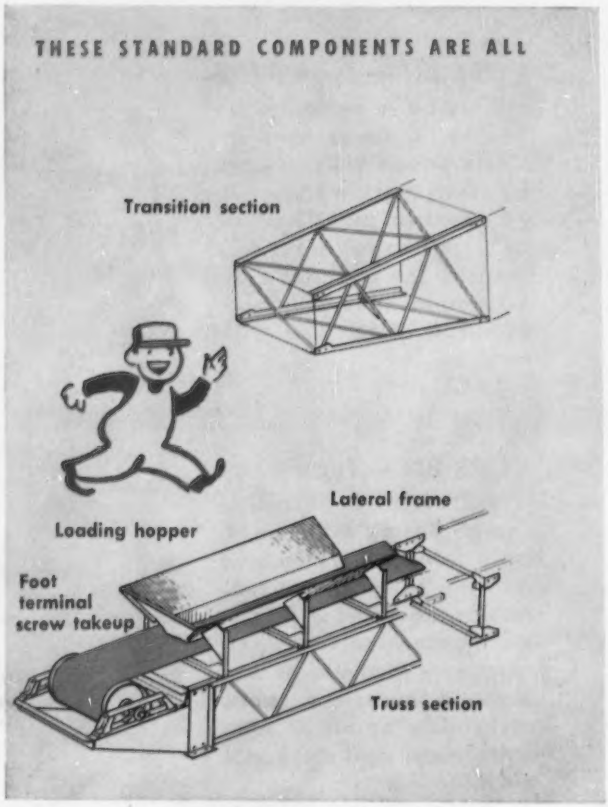
For more information about these conveyors—with drives up to 40 hp and 24 and 42-inch truss depths, write for your copy of Book No. 2579.

LINK-BELT

BELT CONVEYOR EQUIPMENT

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants and Sales Offices in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World.

14.110



AS SIMPLE AS THIS FROM SELECTION TO OPERATION —

EASY SELECTION

Your Link-Belt representative will help you select the best combination of PRE-BILT sectional belt conveyor components.

PROMPT QUOTATIONS

He will prepare a comprehensive and accurate estimate of requirements for installations that permit "on-the-ground" survey.

SIMPLIFIED PURCHASE

Parts are standardized, interchangeable, all available from one supplier. Link-Belt representative can furnish all necessary data.

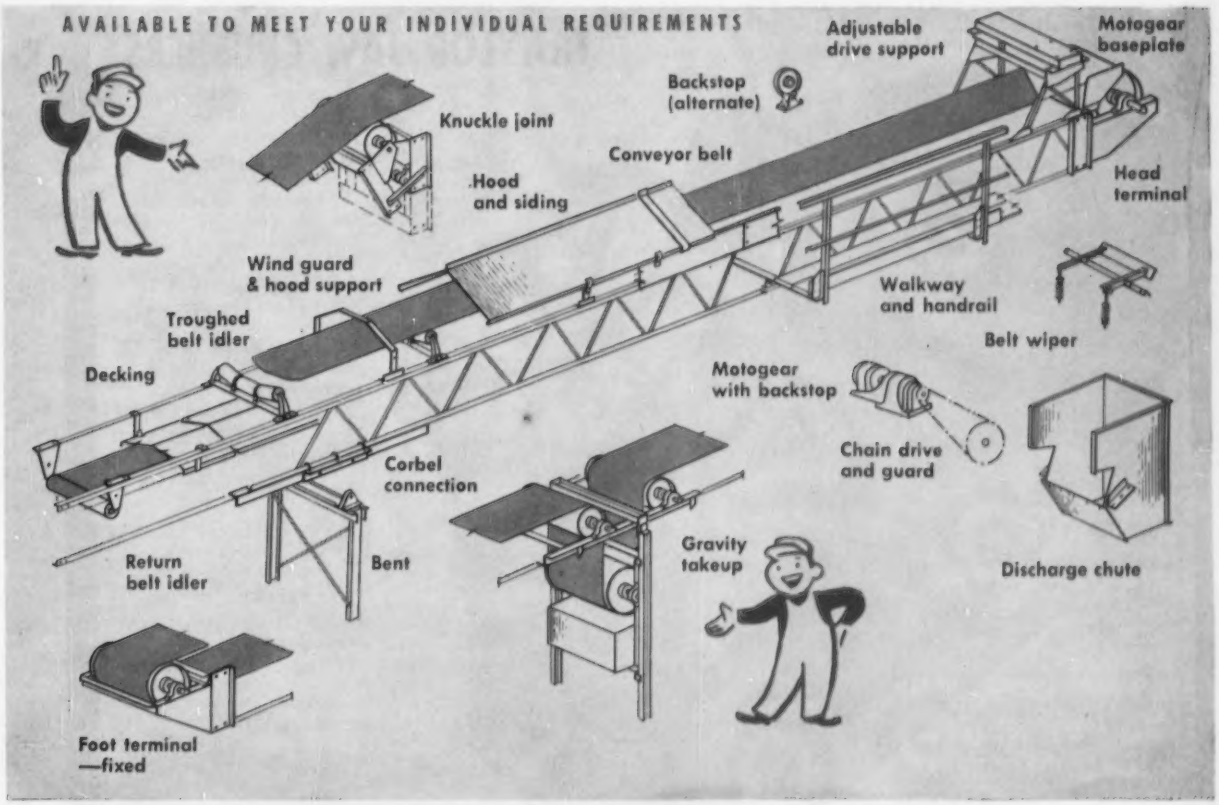
QUICK DELIVERY

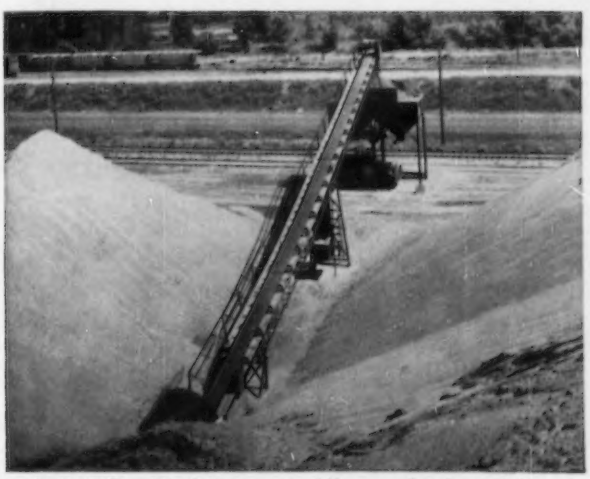
PRE-BILT conveyors are built at nine strategic locations and are shipped from the plant nearest you.

FAST INSTALLATION

Can be readily handled by your own erectors in most cases—due to simple construction and shop-assembled components. Link-Belt can also furnish complete erection service and supervision.

Sectional Belt Conveyors
FOR FAST DELIVERY





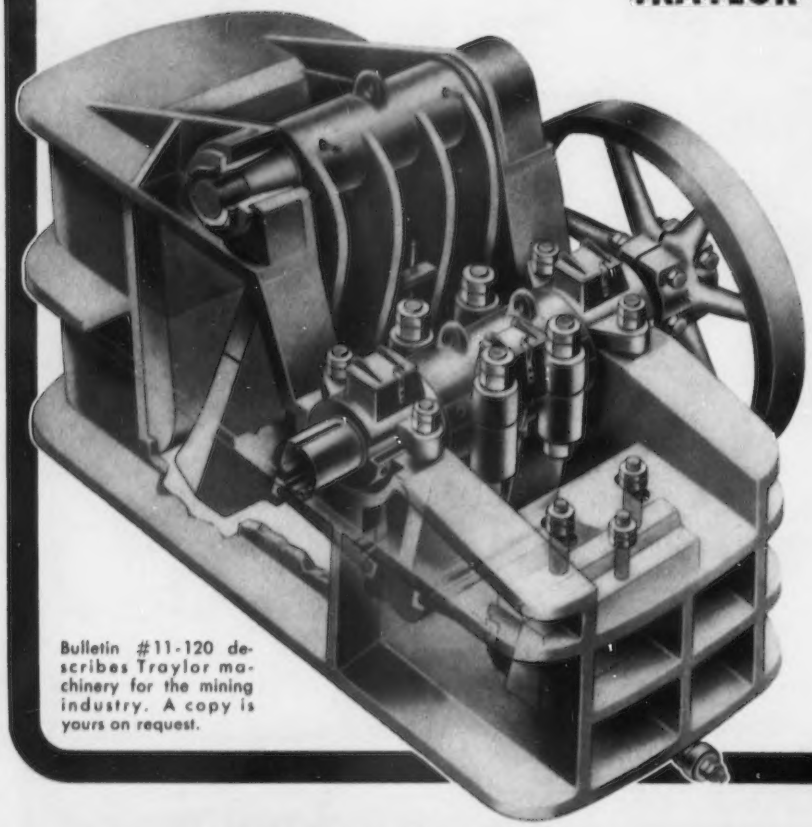
PRE-BILT reclaim belt conveyor delivers sand and gravel from tunnel under stockpile to hopper. System of nine belt conveyors and two radial stackers handles up to 6000 tons per day.

PRE-BILT conveyors can be easily extended to follow mining or disposal operations, as in this system providing low-cost disposal for 1140 long tons per hour of overburden and lean ore.

361 Traylor

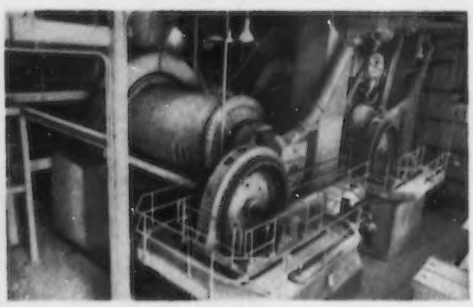
TRAYLOR JAW CRUSHERS

. . . employ many original Traylor design features that add up to greatly reduced operating costs. Heavy duty construction . . . more efficient application of power . . . and Traylor curved jaw plates, that often out-last ordinary plates by as much as 3 to 1 . . . will put efficiency and profits back into your crushing operations. Available in 4 types with feed openings from 8″ x 12″ to 60″ x 84″. Product sizes from 7/8″ to 11″ in capacities up to 1,000 tons per hour.



This cutaway of the Traylor H Jaw Crusher shows the sturdy welded frame . . . the strong pitman . . . the patented swing jaw suspension and curved jaw plates.

Bulletin #11-120 describes Traylor machinery for the mining industry. A copy is yours on request.



TRAYLOR GRINDING MILLS are built in every one of the following types — ball, rod, compartment, tube or pebble — and are designed to grind a wet or a dry material to produce either a coarse or a fine product. Have been built in sizes up to 1500 H. P.

TRAYLOR ROTARY KILNS are used by leading producers the world over for calcining, roasting and chloridizing, volatilizing, sintering and nodulizing. Each kiln is engineered to individual requirements. Sizes have been made to 12′-0″ in diameter and 450′-0″ in length.

MACHINES PROVE it pays to Go By the Record

When buying equipment for profitable production in the Mining and Metallurgical Industries

Traylor-made machinery for the mining and metallurgical industries has proved its ability to produce at a profit in a long line of installations. For more than fifty years, Traylor has been building equipment for all leading companies in these industries. Today you will find Traylor installations operating throughout the world. Use Traylor's past experience to put profits in your operation.

A COMPLETE LINE OF

TRAYLOR GYRATORY CRUSHERS

The extra capacity and efficiency of Traylor Gyratory Crushers is due to the advanced design of Traylor's original Bell Heads and Curved Concaves with increased capacity of each succeeding zone in the crushing chamber. Application of power as a direct crushing force reduces power requirements . . . even at finer settings.

Traylor TY Reduction Crushers and TF Fine Reduction Crushers feature ball-and-socket spring-supported suspension, bronze-bushed eccentric and an auxiliary outside lubrication system. TY Crushers offered in six sizes with feed openings from 3" to 22", capacities up to 590 tons per hour. TF Fine Reduction Crushers are designed especially for the operator who needs a fine product in big volume. Made in four sizes to produce a range of product sizes from ¼" to 1½".

Traylor TC Gyratory Crushers feature a bronze-bushed eccentric, Timken-mounted countershaft and outside lubrication system. Available in seven sizes with feed openings from 20" to 60", capacities from 155 to 4000 tons per hour.

OVER THE PAST TEN YEARS

Traylor Has Built the following machines for use in the Mining Industry

115 JAW CRUSHERS
with receiving openings up to 48" x 66"

92 GYRATORY CRUSHERS
with receiving openings up to 60"

53 ROTARY KILNS
up to 12' x 325'

34 GRINDING MILLS
up to 1500 H. P.

50 CRUSHING ROLLS
up to 72" x 20"

10 CONVERTERS
up to 13'-0' x 30'-0"

7 CASTING MACHINES
up to 41'-3".

A Traylor leads to greater profits

TRAYLOR ENGINEERING & MANUFACTURING CO.
865 MILL ST., ALLENTOWN, PA.

SALES OFFICES: New York • Chicago • San Francisco
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THOR MEANS FAST, LOW-COST DRILLING

Thor air tools are world-famous for balanced power, smooth performance, air economy and low maintenance cost. They are ruggedly built to stand up under the toughest working conditions, designed for balance, for safety and highest efficiency.

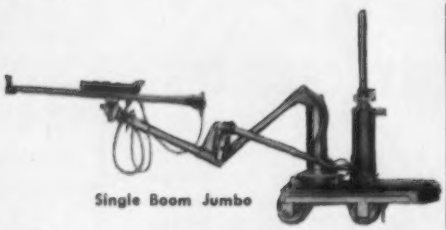
All Thor Rock Drills feature the exclusive Thor Air Valve, a lightweight tubular valve which powers each stroke with the same quantity of air. Ask your Thor distributor or Thor factory service branch for a demonstration. Thor Power Tool Company.

USE POWERFUL THOR MINING JUMBOS

Completely air-operated—no hydraulics. Easiest to set up and operate—operator controls swing of boom without leaving his drilling position. Thor Jumbo drills rounds faster because position is changed so easily. Quick steel changes reduce time per hole drilled. Hollow boom carries all supply and control pipes. Maintenance costs are amazingly low. Easily disassembles to 3 parts for handling in mine cages.

Double Boom Jumbo

Boom column air piston under pressure automatically locks horizontal swing of boom, preventing drift and binding.

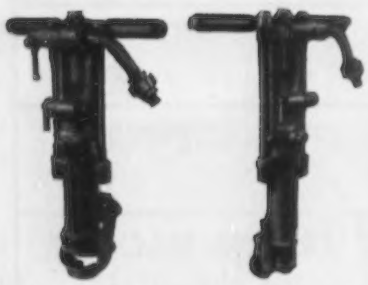


Single Boom Jumbo

Optional track gauges available to and including 36" gauge. Track gauges over 36" available at extra cost.

NEW ROCK DRILLS

MODELS 37 AND 77
FOR WET OR DRY OPERATION



Model 37 (45 lb. class) drills to 12 feet deep in soft or medium rock. Used with Thor Sinker Legs or Thor Guide Shells for drifting; with Thor Raiser for stoping operations.

Model 77 (55 lb. class) drills to 20 feet deep in hardest rock; equals performance of the famous Thor No. 75 heavy duty Sinker for shaft sinking. Both models have renewable bronze bushings in cylinder front bearings.

380-390 PUSH FEED DRILLS

These economical, convenient, efficient all-purpose drilling machines drill at all angles. Drill can be removed from leg for use as a sinker—also adaptable for stoping operations. Features include exclusive Thor 5-position throttle and Thor integral air feed. Available in three leg sizes in feed travels of 36", 48" and 72".

NO. 15 UTILITY HAMMER

This new Thor Air Hammer does what four tools did before—gives you a light demolition tool, a drill, a light clay digger, and a chipping hammer—all in one compact tool. Ideal for drilling survey spad holes, block holing and plugging boulders. Exclusive instant stop rotation feature—simple flick of handy cam lever does it. Easy to use, easy to handle, economical with air. Free-swiveling air connection keeps hose from kinking. Oversize oil reservoir is filled without a wrench.

THOR EXCLUSIVE STOP ROTATION

WEIGHS ONLY 14 LBS.

THOR POWER TOOL COMPANY, Aurora, Ill.

Branches in all principal cities

World's largest exclusive manufacturer of portable air and electric tools

Thor PORTABLE POWER TOOLS

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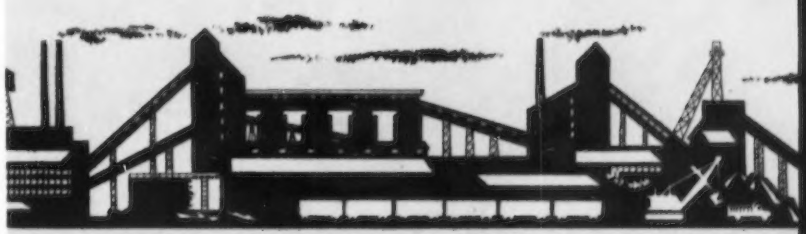
ALLIS-CHALMERS

equipment for the

METALLIC MINERALS INDUSTRIES



Allis-Chalmers is the world's largest manufacturer of equipment for the mineral industries. The wide variety of A-C products has brought together one of the most diversified groups of engineering specialists in all industry. That means you can get expert equipment recommendations from A-C.

There's no guesswork when you specify Allis-Chalmers Engineering. The A-C staff, working with your staff, analyzes your problem or process and looks for ways to make *existing* equipment "team up" with the new equipment for greater production. And the recommendation will be unbiased, because A-C builds many types and sizes of equipment. The selection will be dictated by *exactly what you need*, not an improvised arrangement.

Trained engineers in the Allis-Chalmers Research Laboratories help solve tough problems by testing samples of your product. This is another precaution to make sure that exactly the *right* equipment is selected for your particular plant.

And Allis-Chalmers not only builds the *basic* machinery, but *also* the motors, drives and control needed to run it—it is the only company that builds all this machinery in its own shops. This means a "packaged" unit or process, with every part *engineered* to work efficiently with every other . . . assures you of higher efficiencies, lower costs, undivided responsibilities. And Allis-Chalmers stands behind every unit 100%!

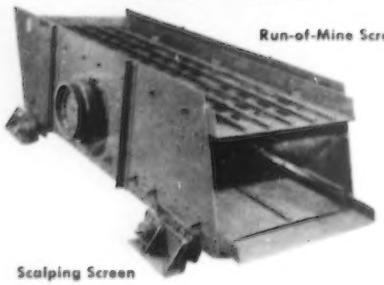
ALLIS-CHALMERS

A-C ALLIS-CHALMERS

25 C 7949B

VIBRATING SCREENS . . . a complete line

Run-of-Mine Screen



Scalping Screen

SCALPING • DESLIMING • SIZING
THICKENING • MEDIA RECOVERY • WASHING

Allis-Chalmers makes a complete line of vibrating screens for every application in the Metallic Mining Industry.

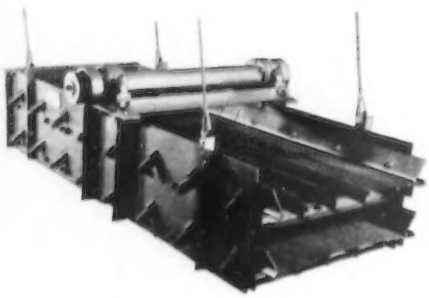
Sizes and types are available for handling the heaviest pit run pieces down to the finest screening problems, wet and dry.

Overhead, suspended or floor mounted units are available in both open and enclosed types.

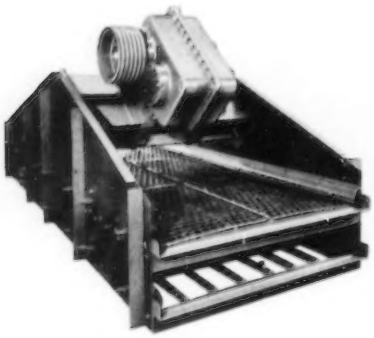
PYRO-PROCESSING EQUIPMENT

• Rotary Kilns . . . for sintering, nodulizing, pelletizing, agglomerating, calcining • Air-Quenching Grate Coolers • Converters • Balling Drums • Rotary Coolers, Dryers • Holding Furnaces • Feeders

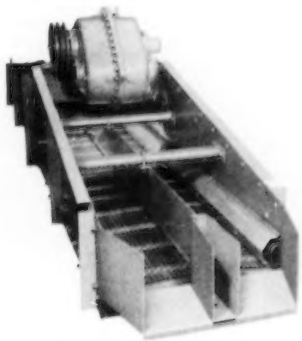
Send for Bulletin 07B6368A



Sizing Screen

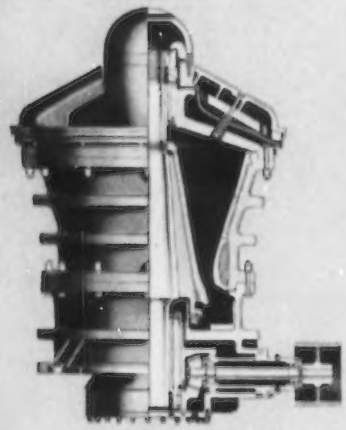


Washing Screen

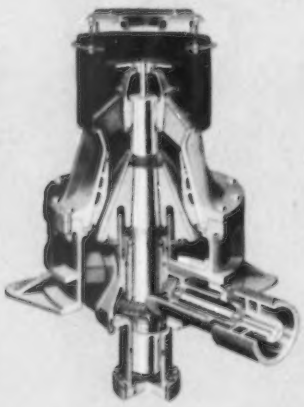


Media Recovery Screen

CRUSHERS FOR EVERY MINING JOB



Primary and Secondary Crusher



Secondary and Tertiary Crusher

Gyratory Crushers

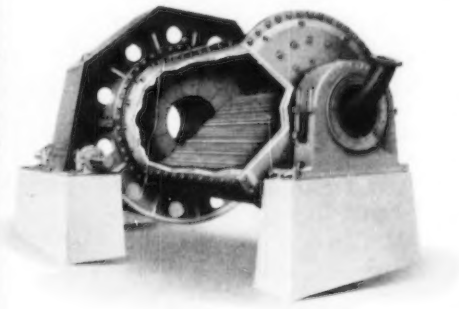
For high capacity primary or secondary crushing . . . *Superior* gyratory crusher sizes 30-55 to 60-109 (60-inch feed opening, 109-inch diameter cone at crushing point). Capacities 170 to 3500 tph. Send for Bulletin 07B7870.

For secondary or tertiary crushing . . . *Hydrocone* crusher, sizes 122 to 1784 (17-inch feed opening, 84-inch diameter cone at crushing point). Capacities 7 to 1050 tons per hour. Available with coarse, intermediate or fine crushing chambers. Bulletin 07B7145.

Hydraulic operation makes possible rapid crusher setting adjustment. On the smaller machines product size adjustments are made with a hand crank, on larger crushers with electrically operated push-button control.

Hydraulic operation also lowers the crushing head to pass tramp iron or other uncrushable materials through the crushing chamber, then raises the head back to the original crusher setting, smoothly and without shock.

GRINDING MILLS . . . all types



Sizes 3 to 11½ ft diameters, 6 to 16 ft lengths. Rod mill product can be varied from 6 to 35 mesh, with a minimum amount of fines. Because a rod mill can reduce a 1-inch slot size feed, it has supplanted the last stage of crushing in many plants. The screening action of the rods within the mill produces an ideal ball mill feed, free from tramp oversize, without the use of close circuiting screens. Bulletin 07B6718.

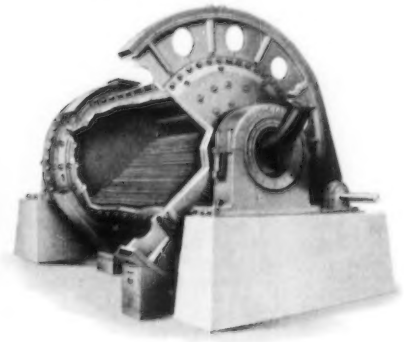
Overflow Rod Mill

Ball Mills

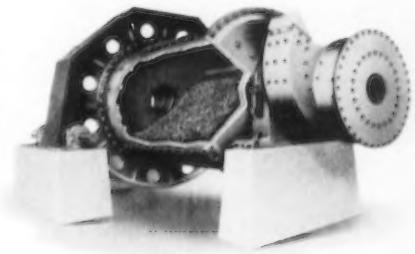
Sizes 3 to 13 ft diameters, 3 to 17 ft lengths. For producing a finely ground product of 28 to 325 mesh from a feed size of about ½ inch. Ball mills are unsurpassed for the fine grinding of moderately to extremely abrasive materials.

Overflow type ball mills are used for fine wet grinding in closed circuit with a classifier. Many processors have turned to this type to reduce liner and grinding media replacement cost. Diaphragm type ball mills are universally used for fine or coarse, wet or dry grinding in closed circuit with a classifier, screen or air separator. Bulletin 07B6718.

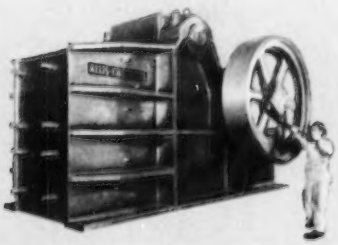
Peripheral Discharge Rod Mill



Sizes 3 to 11½ ft diameters, 6 to 16 ft lengths. The peripheral discharge rod mill was developed for those dry grinding circuits where close control was required for either the product top size or the fines. In addition to these dry grinding applications, either the end peripheral or the center peripheral discharge rod mill may be used in wet circuits where specific product requirements must be met. Bulletin 07B6718.



Allis-Chalmers also builds multi-compartment *Compeb* and *Ballpeb* Mills, Pebble Mills, Preliminator Mills and Blade Mills.



A-1 Jaw Crushers

For primary crushing of tough, abrasive material in blocky feed sizes.

Long, deep crushing has high capacity, minimum slippage and uniform wear. Anti-friction bearings available on some sizes. Four sizes . . . 36 x 25 to 60 x 48 inch feed openings. Capacity 200 to 660 tph.

Bulletin 07B6369.

Blake Jaw Crushers

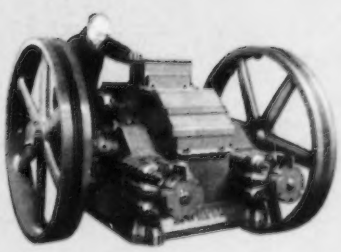
For moderate capacity crushing of hard materials.

A standard reliable double toggle unit with multiple feed gravity lubrication system . . . reversible straight or curved jaw plates. Five sizes . . . 10 x 7 to 30 x 18 inch feed openings. Capacity 6 to 90 tph. Bulletin 07B7090.

Fine Reduction Jaw Crusher

For crushing 7 inch and smaller feed to 50% passing ¼ inch in one operation.

A single toggle machine with reversible curved jaw plates . . . anti-friction bearings. Two sizes . . . 18 x 9 and 24 x 10 inch feed openings. Capacity 4 to 36 tph. Bulletin 07B6425.

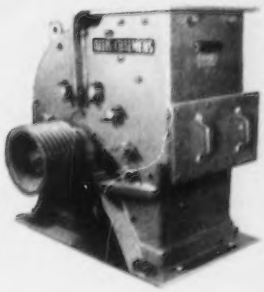


Roll Crushers

For fine crushing of hard material with minimum fines.

Double Roll Crushers are driven independently by large flywheel sheaves. Roll diameters, from 9 to 78 inches. Bulletin 07B6180.

Single Roll "Fairmount" Crushers are built in two sizes for crushing large tonnages of laminar rock.



Hammermill—Pulverator

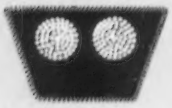
For pulverizing soft or non-abrasive materials.

Hammers reduce material by multi-impact . . . large ratio of reduction. Handles up to 4 inch feed. Five sizes . . . Capacity 2½ to 125 tph. Bulletin 07B6265.

A DRIVE FOR EVERY MACHINE

***Texrope*—greatest name in V-belt power transmission—is the registered trademark of Allis-Chalmers, originator and pioneer of multiple V-belt drives.**

Ask for Bulletin 20C6051, "Handy Guide to Selection of *Texrope* Drive Equipment"; it tells the complete *Texrope* Drive story . . . V-belts . . . sheaves . . . and how to figure a *Texrope* drive.

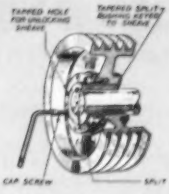


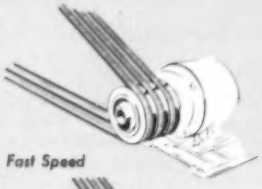
Grommet Belt

Wide Range Belt

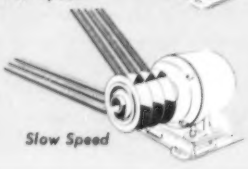
Texrope V-belts

Famous patented grommet construction provides longer life than ordinary V-belts. Made with straight sides for greater grip. Types for all operating conditions: heat-resisting; oil-resisting; static-resisting and special High Capacity. Also available: *Texrope* wide range V-belts for use with wide range *Vari-Pitch* sheaves and *Vari-Pitch* Speed Changers.





Fast Speed



Slow Speed

Magic-Grip Sheaves

The *Magic-Grip* cast iron sheave provides fast, easy mounting and demounting. Construction is simple, foolproof. Sheave automatically adjusts itself to slightly oversize or undersize shafts. Positive clamp fit on shaft means no weaving—no vibration. There is no back lash—no extra play. Sheave can be mounted closer to motor or machine—reducing strain and stress. Result: bearing pressure eased—bearing life increased.

Stock sizes for drives up to 150 hp. Larger sizes available on order.

Vari-Pitch Sheaves and Speed Changers

VARI-PITCH SHEAVES are available in two types; Standard Range for A, B, C, D or E belts—capacities from 1 to 300 hp—speed variations up to 28%. Wide Range for Q and R belts—capacities from 1½ to 40 hp—speed variations up to 100%. Both types designed with stationary or motion control features—Stationary Control for infrequent changes when sheave is stopped; Motion Control for repeated speed changes while sheave is in motion.

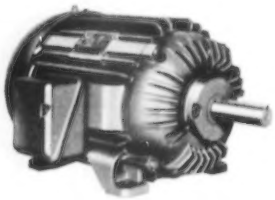
Vari-Pitch Speed Changers furnish 3¾ to 1 speed ratio in one compact, enclosed unit. Adjustable while in motion. Combines two wide range, worm gear-adjusted sheaves. Manual or pushbutton control.

MOTORS FOR EVERY DRIVE

Allis-Chalmers builds a *complete* line of polyphase squirrel cage, wound rotor, synchronous, and direct current motors with electrical and mechanical modifications to meet *any application*. Ask for Bulletin 51C6052, "Handy Guide for Quick Selection of Electric Motors"; it furnishes you with enough facts on Allis-Chalmers motors to enable you to select the type which meets your required electrical and mechanical specifications. The next time you need an electric motor, contact your nearby Allis-Chalmers representative.

Drip-Proof

Small, tough, general purpose squirrel cage motors. All-around protection of inner parts. ½ to 200 hp and up. Also in splash-proof types. Bulletins 51B6210 and 51B7693.



Enclosed Fan-Cooled

Protected from dust, grit, vapor, gases. Cooling air circulated around exterior. ½ to 100 hp. Bulletin 51B7225. Also in new tube cooled type to 3000 hp.

Wound Rotor

For adjustable varying speed service. High starting torque, low starting current. Bulletins 51B-6052 and 05R8183.

Synchronous

High torque motors of constant speed, available in ratings of 40 hp and larger. End shield bearing, pedestal bearing and engine types.

Large Induction

Drip-proof or splash-proof. 60 hp at 300 rpm to 200 hp at 1800 rpm. Bulletins 05B7542. Pedestal bearing types, 05B7771.

CONTROL FOR EVERY MOTOR

Allis-Chalmers makes a line of starters to meet practically all motor control needs. Count on this wide range of starters, backed by industry-wide application engineering experience, for the answer to your control needs. Ask for Bulletin 14B7733.

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Exploration

A panorama of some of the most important tools of modern exploration technology is laid out on these 20 pages. Here are the high spots for the perspective of the experienced exploration man, and for the guidance of those whose positions now require, or will require, knowledge of the field. Here is what the key pieces of exploration equipment can do; their advantages, limitations and applications.

VERNON READ
Resources Development Corp.
Denver, Colo.

Vernon Read's first by-line in *E&MJ* appeared in the January 1951 issue over an article on how research could be made to pay off. At the time Mr. Read was a mining engineer with Noranda Mines. In this issue, *E&MJ* is cashing in on his research into exploration equipment which provides you with 20 pages of useful information culled from scores of letters, interviews, manufacturers' literature and field trips.

In the interval between by-lines, Mr. Read served for a few years on the editorial staff of *Architectural Forum*, but last year he came back home to mining. Joining Resources Development Corp., he has taken active part in the company's exploration programs. As a matter of fact a great deal of the manuscript for this Guidebook section on exploration was written this past winter on a prospect in northern Ontario with the mercury outside the tent hovering at a cool 40 deg below.

Planning the Exploration Program

SYSTEMATIC SURFACE EXPLORATION cuts drilling costs. Probably the biggest gamble in mineral exploration occurs on the initial drilling program to determine the extension at depth of a promising outcrop, or the cause of an interesting geophysical anomaly. Yet too often, costly core drilling programs are undertaken without thorough surface exploration of the outcrops, surface values, or the dip, plunge and strike of a potential prospect.

Wherever possible, an option on a property should allow sufficient time to undertake two stages of work on it: first, thorough surface exploration and then, after re-evaluating the property, bring in the drilling equipment.

Surface exploration should include thorough stripping to expose all interesting outcrops and the careful collection of channel samples. Bulldozing is a valuable time-saver in decomposed rock, soil and over-burden. It can make a cut about 500 ft long and 8 to 12 ft deep in a single 8-hr shift for costs of 2 to 5c per cubic yard.

Channel samples must be taken with great care, always from fresh rock at the bottom of a trench blasted out of an outcrop. The number of samples will depend on the size and nature of the deposit. There should be at least two taken systematically from each exposure. Grab samples may be interesting, but they are far less reliable than systematic channel sampling.

In the iron deposits of Labrador, trenches were dug at 400-ft intervals across the strike; where the overburden was more than 6 ft deep pits were dug 50 ft apart along each line, often with the aid of bulldozers or small power shovels fitted with backhoes having a digging depth of 15 ft.

In all except the most massive deposits, light exploratory drilling to depths of 80 to 100 ft is essential to check dip and plunge of a vein or a dike. Light coring equipment can be taken in at little cost and may save considerably on the second phase of the work, by eliminating valueless holes drilled on the wrong side of a dip. The cores obtained will also provide surface assays.

Planning the Drilling Pattern

Drilling may be carried out to obtain geologic information, to detect an ore deposit, or to outline and appraise a deposit already found. For the first two objects, core drilling is a must. For the last, core drilling is useful, but not essential. Churn, wagon or rotary-percussion equipment with collection of dust or sludge samples, drills faster and cheaper.

On the Colorado Plateau, core drilling costs run around $3 per ft, excluding overhead and evaluating charges, compared to only 57c per ft (on large contracts) for noncoring percussion drilling. Coring averages less than 40 ft a shift compared to 300 to 500 ft for noncore drilling. As a result, most of the AEC drilling on the Colorado Plateau is noncore air drilling, with samples collected every 2 ft.

Vertical Drilling On the Colorado Plateau

AEC Exploration Director Ernest R. Gordon reports that drill patterns in searching for and delimiting favorable ground on the Colorado Plateau depend on the formation being probed. The fairly flat and tabular Morrison formation is drilled with a square grid pattern with hole intervals up to 1,000 ft. Chinle channels, having orebodies elongated in one general direction are probed by a fence pattern of closely spaced holes 50 to 100 ft on center in widely separated rows 500 to 1,000 ft apart. Sometimes a modified grid pattern is employed by using a diamond grid with the long

Light Reconnaissance

Drill	Manufacturer	Capacity (feet)	Diameter (inches) Hole	Core	Power[1]	Transmission	Feed	Length of feed (inches)	Core barrel
Packsack	Packsack Diamond Drills, Ltd.	100	1¼	⅞	5½ hp, G	Direct	Manual	24	Single tube
Super Pioneer	Diamond Drill Contracting Co.	100	1⅜	½	5 hp, G	Direct	Manual	24	Single and double tube
DL-375s	Lovequist Engineering Co.	4	3	...	⅝ hp, E	Direct	Manual	....	....
DL-874s	Lovequist Engineering Co.	150 EX	...	½	2½ hp, E	Direct	Manual	....	....
DL-875s	Lovequist Engineering Co.	...	...	...	1 hp, E	Direct	Manual	....	....
X-ray XR XRT	Boyles Bros. Drilling Co., Ltd.	200	1⅜	...	7 hp, G	Direct, 2-speed	Screw	14	Single and double tube
Porta	Canadian Longyear, Ltd.	150	1⅜	¾	3½ hp, G	Direct	Screw	....	Single and double tube
Prospector	E. J. Longyear Co.	300	1½	1⅜	5½ hp, G	3-speed	Screw	20	Single and double tube
Drill Scout	Gustafson Mfg. Co., Inc.	200	...	½	6 or 9 hp, G	...	....	....	Single tube
Mini Drill	Du-Jac Mfg. Corp.	300	1⅛	½	6 hp, G	...	Screw	20	Single and double tube
Holeycat	Atomic Engineering Corp.	300	1⅜	⅝	6.6 hp, G	...	Hydraulic	60	Single and double tube

[1]Power: G-gasoline; E-electric; D-diesel.

axis in the direction of orebody elongation.

Favorable ground is then drilled in a closer pattern, successively halving the grid or fence distance until ore is found or the interval becomes so small that an economic deposit could not exist between holes. Air rotary, wagon or diamond core drilling is optional at this stage, but sufficient coring is advisable to compare core assays with gamma logs and assays of cuttings to make a correct evaluation of ore grade.

AEC drilling of the vertically standing Tertiary deposits in Wyoming favors angle holes, again using both coring and noncore drilling. To speed the work, two holes are generally drilled from one setup, one hole designed to intersect the vein at a depth of 100 ft, and a second hole at a greater dip to intersect at 200 ft depth.

Faraday Uranium Prospected With Angle Holes

Geologist R. B. Allen emphasizes close exploration drilling of shallow, two-mining level blocks of ore rather than doubtfully correlatable test holes over a greater range in depth to explore ground at the Faraday Uranium Mines, Ltd. at Bancroft, Ontario. After preliminary air contour mapping and air and ground radiometric surveys, lines of diamond core drill holes were put down 200 ft apart across the strike of an anomaly. Holes were drilled at 45-deg angles 100 ft apart on each line, against the dip of the body. A few more holes were drilled along the strike and down dip to check persistence of mineralization. The 100-ft interval between holes allows a good chance of two holes cutting the same stoping shoot.

Churn Drilling at San Manuel

Churn drilling is often used to sample massive sulphide deposits because it is economical and cuts a relatively large diameter hole to yield a large and representative sample. At San Manuel Mines in Arizona, the orebody was drilled out with 109 six-inch churn drillholes to a depth of 2,850 ft. At the start of the drilling program, vertical holes were drilled 400 ft on center along the strike and 200 ft on center across it. Later, when the short axis of the body was found to be almost as long as the long axis, holes were drilled 400 ft on center in both directions. In addition to 205,536 ft of churn drilling 39,737 ft of diamond core drilling was put down for geological correlation. This program established a 479-million-ton orebody averaging 0.769% copper.

Drilling rigs may be leased or purchased outright for direct operation by the company developing the prospect, or the work may be contracted out to one of the many reputable drilling companies. Today as drilling contractors become more efficient and experienced, the trend is to more contract drilling, with one important exception—most exploration companies like to own small highly portable reconnaissance drills that can be quietly trucked or flown into new mining territories for inexpensive shallow exploration drilling without attracting undue attention. These light drills can be operated by one or two men.

Contracts for exploration drilling range from the standard cost per foot contract, which will contain certain cost-plus escape clauses for unforeseeable delays due to excessive overburden, cementing, long water lines and long moves between drillholes, etc., to a straight cost-plus contract, with the "plus" ranging from 10 to 15% depending on the size of the contract. The cost-plus contract is generally employed for drilling in new territory where drilling costs are unknown or in winter where sub zero temperatures might interfere with moving or supply.

In estimating the minimum appropriation required for a drilling program, at least 50% should be added to the standard base cost per foot drilled for administration, engineering, assays and other overhead. In severe winter drilling where supplies must be flown in, add 100% to the base cost for time lost due to bad flying weather.

Drills (to 300 ft)

Hoist	Derrick, max. rod pull (feet)	Bit speed (rpm)	Mount	Weight (pounds)	Cost
None	None	1,500	Hand-held	32-drill, 48-pump	$750 complete with pump
None	None	1,250	Hand-held	35-drill, 49-pump	$785 complete with pump
None	None	1,000	Hand-held	7	$216
None	None	900	Hand-held	45	$967
None	None	900	Hand-held	37	$942
None	None	300–500	Skid	190 with integral pump	$1,750 complete with 100-ft rods
None	None	to 1,250	Skid	260 with integral pump	$950 drill and pump only
Spool	10	1,730	Skid	600	.....
Spool	6	500	Trailer	1,000 with pump	.....
....	10	1,200	Skid	400 with mud tank	.....
Hydraulic	...	2,400	....	300 with mud tank	$2,950

Light Reconnaissance Drills

LIGHT RECONNAISSANCE DRILLS play an important part in nearly all well-rounded exploration programs. Properly used during the stripping and surface sampling stage of developing a prospect, they give highly valuable information as to the dip, strike, plunge and grade of a potential ore formation just beneath the surface. Neglected, lack of such information often leads to considerable wasted footage drilled with heavier equipment because of drilling on the wrong side of a strike or away from a plunge. Light reconnaissance drills are also useful for drilling flat holes just beneath the surface of a vein outcrop for sampling or channel blasting.

The main requirements of reconnaissance drills are portability and good drilling ability, at least to depths of 50 to 80 ft. They are generally direct drive machines driven by gasoline engines of up to 9 hp, weigh 400 lb complete with single tube core barrels and 80 ft of drill rod. The lightest machines are handheld, forced into the ground with the help of a lever hooked into an eyebolt set in the ground. A separate 1-hp pump supplies drilling water, but if the water source is more than about 100 ft distant, a second pump is required to pump water to a barrel at the drill. These rigs are light, and consequently freeze up quickly at sub-zero temperatures. They are proving highly popular in Canada because of their extreme mobility, and do perform useful work under good conditions and careful operation. They cost from $750 to $950 depending on the amount of accessory equipment included in the "kit."

More rugged, and heavier reconnaissance drills have regular drill heads with one- to three-speed gear feed controls and integral pumps. Derricks to help in rod pulling can be built as desired, pulling rods with the aid of a cathead if provided on the drill, or by using a block and tackle to assist hand pulling in deeper holes. These machines weigh from 190 to 600 lb, cost from $967 to $2,950 and can be mounted on skids, trailer or jeep as desired.

Portable Rock Drills

Drill	Manufacturer	Type	Power	Capacity (feet)	Weight (lb)	Angle of Holes	Cost
Pionjar	Stanco Mfg. & Sales, Inc.	Piston	Gasoline	13	86	Down & up to 45 deg	$650
Warsop	Warsop Power Tools Ltd.	Piston	Gasoline 2½ hp	10	90	Down holes only	$650
Pinazza	Pitman Indl. Products Co.	Air piston or electric rotary	3½- to 5½-hp gas engine drives compressor or generator	16½	Drill, 49 power units, 90 to 115	Up to 45 deg	—
Demo	Demo Tool Corp.	Rotary core	880w Electric	100 ½-in. dia.	50 excl. generator	Up to 45 deg	—
Syntron	Syntron Power Tool Co.	Piston	Gasoline	10	118	Down only	—
Homelite	Homelite Corp.	Rotary	Electric 5½-hp gasoline generator	—	Generator, 125 Drill, 65 Blower, 20	Up to 45 deg (Jackleg available)	$1,352
Hossfield	Hossfield Mfg. Co.	Piston	Gasoline 7½ hp	110 2⅝-in. dia.	1,300 with 70-ft steel	Down holes only	$950
Mighty Midget	Houston Tool Co.	Rotary	Gasoline 9 hp	100	125	Any direction	—

Medium Exploration

Drill	Manufacturer	Capacity (feet)	Diameter Hole (inch)	Diameter Core (inch)	Power[1]	Transmission	Feed
Teredo LD	Acker Drill Co., Inc.	400 EX	...	...	5 hp, G	3-speed	Hand lever
S&H L-2	Sprague & Henwood, Inc.	500 EX	1½	⅞	10 hp, G	V-belt	S
Pioneer Straitline	E. J. Longyear Co.	600	1½	13/16	G	3-speed	Screw, or hydraulic
S&H 30	Sprague & Henwood, Inc.	600 EX	1½	⅞	12 hp, G or D	3-speed	S, H
Teredo TH	Acker Drill Co., Inc.	800 AX	...	⅞	18 hp, G or D	3-speed	S, H
Junior Straitline	E. J. Longyear Co.	1,000	1½	13/16	E, G or D	....	S, H
CP-8	Chicago Pneumatic Tool Co.	1,000 AX	...	1⅛	25 hp, G or D	4-speed	S, H
S&H 40-C	Sprague & Henwood, Inc.	1,000 EX	1½	⅞	24 hp, G or D	4-speed	S, H
NXO Hydraulic	Diamond Drill Contracting Co.	1,000 NX	2¾	...	31 hp	4-speed	H
CFD-1 Combination	George A. Failing Co.	1,000	2⅜	...	Power takeoff, min. 140 hp	4-speed	H
Mayhew 1,000	Mayhew Supply Co., Inc.	1,000	3½	...	.....	3-speed	Rotary table
BBS-1	Boyles Bros. Drilling Co., Ltd.	1,200 E	...	...	25 hp	4-speed	S
1500 Combination	George A. Failing Co.	1,500	2⅜	...	Power takeoff, min. 140 hp	4-speed	H
BHD-C	Winter-Weiss Co.	1,500	8	...	Power takeoff	Chain	Rotary table
CP-15	Chicago Pneumatic Tool Co.	1,800 AX	...	1⅛	45 hp, G, 35 hp D	4-speed	S, H
UG Straitline	E. J. Longyear Co.	2,000	1½	13/16	E, G or D	4-speed	S, H
S&H 142	Sprague & Henwood, Inc.	2,000 EX	1½	⅞	30 hp, G, or D	4-speed	S, H
AX Hydraulic or Screw	Diamond Drill Contracting Co.	2,000 AX	1⅝	...	51 hp	4-speed	S, H

[1]Power: E-Electric; G-Gasoline; D-Diesel.

For Deeper Holes, Diamond Drill Designs

CFD-1 COMBINATION has collapsible mast for easy traveling in bush or highway.

THE DESIGN of diamond core drilling equipment has improved tremendously with the increase in core drilling activity since World War II. Main emphasis has been on greater power, smoother and more efficient transmissions, improved mobility and flexibility, stronger and more durable parts, and more reliable, maintenance-free, low-cost operation.

On these four pages are tabled the main characteristics of medium and heavy exploratory drilling equipment. For convenience, drills with capacities of 300 to 2,000 ft EX core are classified as medium, those wtih capacities greater than 2,000 ft as heavy exploration drills. The drills listed are by no means the only equipment available, but are presented to show the types of rigs being used in mineral exploration drilling today.

In construction, the diamond drill consists of a boring column driven by a gasoline, diesel, electric or compressed air motor through a swivel head or rotary table. Drill water is

Drills (300 to 2,000 ft)

Length of feed (inches)	Hoist	Derrick, max. rod pull (feet)	Bit speed (rpm)	Mount	Weight (pounds)	Cost
24	Cathead	Vertical	900	Skid, truck or trailer	500	$ 2,200
20	Drum	....	1,000	Skid, truck or trailer	1,400	
S-20, H-18	Drum	20	....	Skid	970	
S-20, H-30	Drum	....	1,400	Skid, truck or trailer	1,350	
24	Cathead	....	900	Skid, truck or trailer	2,300	$ 3,000
S-20, H-18 to 30	Drum	20	....	Skid or trailer	1,700	
S-18, H-24	Drum	....	1,050	Skid	G-1,650; D-2,400	
S-20, H-30	Drum	1,400	....	Skid, truck or trailer	1,890	
24	Drum	....	1,350	Skid	3,400	$ 5,500
30	....	Vertical	72 to 220 rotary	Truck, min. base 157 in.	22,000	$20,000
....	Drum	31–22 ton	50 to 325	All		
24	....	....	1,000	Skid, truck or trailer	1,145	$ 4,873
30	Drum	Vertical	40 to 214 rotary	Truck, min. base 175 in.		$21,500
....	Drum	Vertical	....	Truck		
S-18, H-24	Drum	....	1,500	Skid	G-2,300; D-3,000	
S-20, H-30	Drum	20	....	Skid or truck	2,200	
S-20, H-30	Drum	....	1,200	Skid, truck or trailer	3,300	
24	Drum	....	1,250	Skid	3,250	$ 5,150

Stress Power, Mobility, Durability, Economy

pumped into the drill rods by a separate pump. The rods are raised and lowered by a drum hoist and wire rope, which passes over a pulley block at the top of a derrick. The derrick can be prefabricated of light tubular steel or aluminum, hydraulically raised and lowered on truck-mounted rigs, or a timber tripod can be built at a drillsite where sturdy trees can be found.

The boring column consists of a

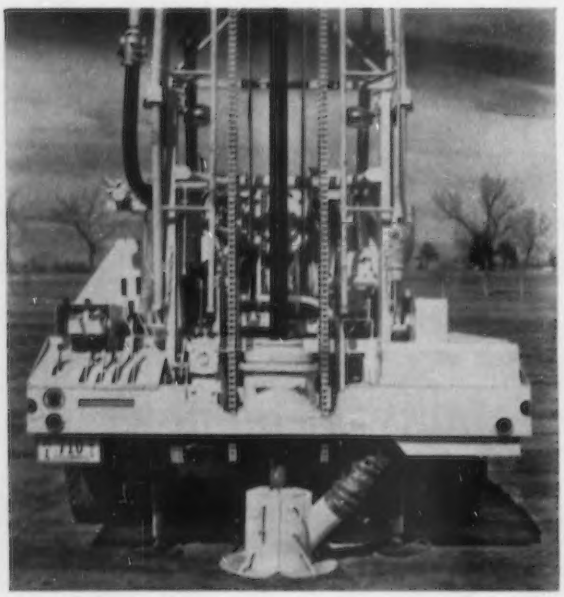
TEREDO TH has capacity of 800-ft depth with 18-hp engine.

JUNIOR STRAITLINE comes with screw or hydraulic feed.

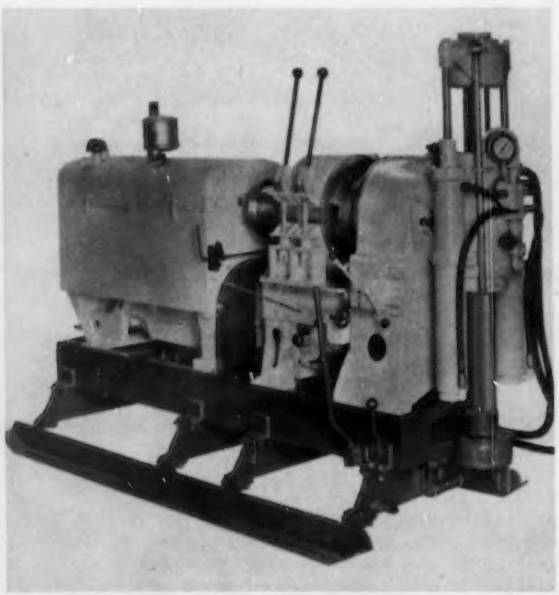
Heavy Exploration

Drill	Manufacturer	Capacity (feet)	Diameter Hole (inches)	Diameter Core (inches)	Power[1]	Transmission	Feed
Mayhew 2000	Mayhew Supply Co., Inc.	2,000	3½	...	G or D	4-speed	Rotary table
BBS-2	Boyles Bros. Drilling Co., Ltd.	2,400 AXT	1⅞	1⅝	70 hp, G or D	5-speed	S or H
Failing 2500	George A. Failing Co.	2,500	3½	...	G or D	4-speed	Rotary table
Mayhew 3000	Mayhew Supply Co., Inc.	3,000	3½	...	150 hp, G or D	4-speed	Rotary table
Longyear 44	E. J. Longyear Co.	4,000	1⅞	1⅝	45 to 63 hp, G or D	4-speed	Twin hydraulic
Master Straitline	E. J. Longyear Co.	4,250	1 13/16	1⅝	50 hp, G, D or E	4-speed	Hydraulic
DH-5	E. J. Longyear Co.	10,000	3	2⅛	G, D or E	...	Twin hydraulic

[1]Power: G-Gasoline; E-Electric; D-Diesel.



PORTADRILL BHD-C has integral dust collecting, sampling.



LONGYEAR 44 will hit 4,000 ft with 45- to 63-hp engine.

drill bit, core shell, core barrel and hollow seamless steel drill rods, all rotated within sets of casing as required.

Most of the drills can be mounted on skids, when the unit can be moved under its own power using the hoist to winch itself along; on trailers, when the towing truck is freed for servicing duties; or on trucks, when the drill can be driven by a power takeoff from the engine of the truck. The lighter drills can usually be disassembled quickly into a number of small, compact loads for air lift by light bush planes into remote districts. Prices and weights of drill rigs range from about $2,200 and 500 lb for the 400-ft capacity Teredo LD, to $25,000 or $30,000 and around 30,000 lb for a truck-mounted, 5,000-ft capacity rig.

Power Units: Drill motors range from 5 to 70 hp, and to 140-hp truck engines using power takeoff. In all but the lightest drills the trend is away from gasoline to diesel engines because the diesel engine is more durable, has better lugging power at low speeds, is more efficient and its greater economy of operation is such as to pay for the extra cost of the diesel unit within the first year of operation. Compressed air and electric drill motors are used for underground exploration.

Transmission: Drill motors have 2- to 5-speed transmission and reverse. Considerable study is being made into the use of fluid drive and torque converters, which reduce the shock load on the drill motor and the boring column. So far their use is limited to the bigger drillrigs but the development could well prove to be extremely helpful.

Feed Mechanisms: Most drills can be obtained with swivel heads equipped with either screw or hydraulic feed. Differential screw feeds generally have three- to four-speed drives permitting feed rates of 100 to 1,000 revolutions per inch of the feed-screw spindle. The usual advance per run with screw feed is 18 to 20 in.

Hydraulic feed is used almost universally on the larger drills. Water pressure is used to control the motion of a piston rod, which feeds forward the drill rods through a chuck. A pressure gage measures the thrust on the rods. Hydraulic feeds may have one or

Drills (over 2,000 ft)

Length of feed (inches)	Hoist	Derrick, max. rod pull (feet)	Bit speed (rpm)	Mount	Weight (pounds)
....	Drum	58–30 ton	50 to 300	Skid, trailer or Truck	...
....	....	30	2,000	Skid	3,000
....	Drum	58–45 ton	....	Truck	...
....	Drum	85–50 ton	....	Trailer	...
24	Drum, 4-speed	...	1,200	Skid, trailer or Truck	4,500
18 to 30	Drum	...	....	Skid or truck	7,200
30 to 120	Drum	...	....	Skid	...

MAYHEW 3000 employs rotary table for drilling, can pull 50 tons of rods.

two cylinders, the advance per run being from 18 to 120 in.

Hydraulic feed is best in broken or vuggy ground since the feed pressure is constant and there is consequently no danger to the bit or passing from soft to hard ground. In spite of this, many drillers prefer screw feed, claiming that the constant advance of the screw feed tells them of slight differences in the hardness of rock, and of the presence of thin seams or crevices. However, in varying ground, it is necessary to run through soft strata at reduced speeds so that the bit may not be damaged on meeting hard rocks. A further advantage of hydraulic feed is that in deep holes the weight of the drill rods is conterbalanced to maintain optimum pressure on the bit and to avoid damaging the bit on drilling through cavities. Greater running experience is required for hydraulic feed equipment to avoid costly mistakes.

In deeper holes the oil drilling rotary table is used in place of the chuck. The table is a 2- to 3-ft diameter horizontal wheel with drive sprockets on the outer circumference and a square hole at the center. Through this hole passes a 30- to 60-ft-long "Kelly," a drill rod of square section that supports and drives the drill pipe below, and is suspended from a multiple hoisting block above so it is free to move up and down. Rotary drilling is done with diamond or roller bits for hard rock, fishtail bits for softer rocks, at drill speeds up to 400 rpm.

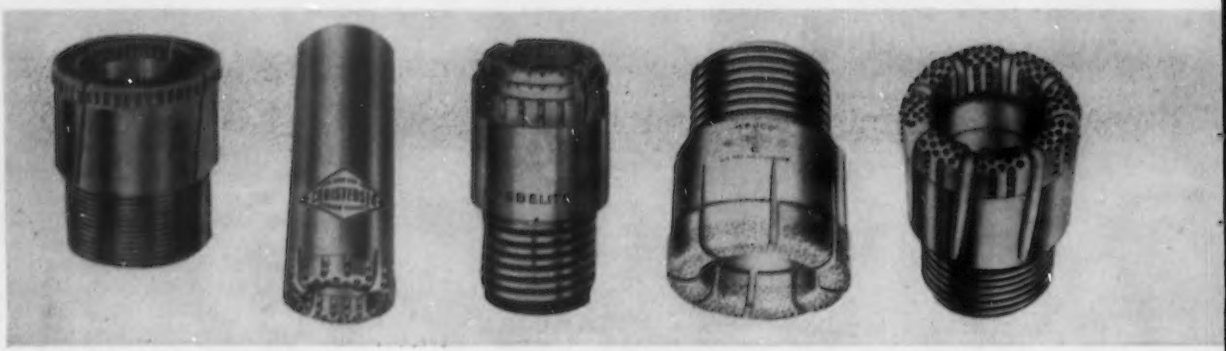
Hoisting Drum: This is usually a two or more speed drum driven by gearing from the crankshaft. A compound gear reduction is provided for deeper holes where the weight of drill rods may be several tons. On light drills, the hoisting drum is sometimes omitted, the rods being raised by a rope coiled around a cathead.

Derricks: A tripod timber derrick for holes to 600 ft deep is made with legs 4x6 in. and about 30 ft long to give a 20 ft clearance. For 1,000-ft holes the legs should be 6x6-in. timbers; deeper holes would require steel derricks. Drill rods of up to 40 ft long can be stood up in a derrick without excessive bending; longer rods should be hung from above.

Calyx Drilling: Calyx or shot drills can be used to drill large holes up to 72-in. diameter in hard, well-standing ground where the holes are to be vertical or at an angle of not more than 35 deg off the vertical. It is often used for boring exploration shafts and for ventilation shafts, ore and waste chutes. A bored shaft often stands without support whereas a conventional shaft might require timbering where the walls have been shattered by explosives. Costs may range from $7 to $45 per ft depending on the diameter and the depth drilled.

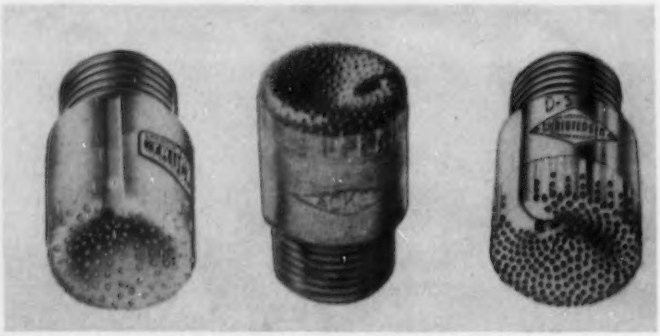
The calyx bit is a tempered steel cylinder having two diagonal waterways. Chilled-steel shot, 1/16-in. diameter and under, fed into the rods with the wash water, pass into the core barrel and under the bit where they serve as an abrasive medium when the bit is revolved at 50 to 100 rpm. As the drill rods are of smaller diameter than the calyx, the velocity of the rising sludge is decreased and the coarser particles are deposited in the calyx where they do not interfere with drilling and do not require excessive water pressures to carry them to the surface. After drilling, the core is raised by wedging it in the barrel with angular pieces of quartz dropped through the drill rods. Most calyx drills are driven through rods from the surface; large holes are sometimes drilled with the driving mechanism and operator in a cage just above the core barrel at the bottom of the hole, the cage being prevented from turning by jackscrews tightened against the walls of the hole. Where necessary, the cores are broken with hand-driven wedges.

Further information on drilling equipment is available in the section on open pit mining (pp 60 to 65).



CORING BITS have been designed for almost every type of geologic formation that may be encountered in the field. Some

PILOT BITS help keep holes straight in dipping strata.



CONCAVE BITS offer fast drilling where no core is desired.

Drilling Recommendations*

Type of bit	Rock conditions	Pressure and rotational speed
Bortz bit with relatively few large stones	(a) Soft to medium hard rock, medium to coarse grained.	Moderately heavy pressure and medium rotational speed
	(b) Rock with soft particles mixed with hard coarse-grained particles	Heavy pressure and somewhat higher speed
	(c) Hard rock and deep drilling	Increased speed and heavy pressure. Heavy drill required
Bortz bit with large stones. Large clearance on bit and reamer. AX size bit	Fibrous rock (asbestos)	Medium pressure and speed. Very high water pressure and volume
Bortz bit with large number of small stones	Hard, solid ground	Lighter unit pressure than for a bit with larger stones. To avoid polishing, increase the pressure as speed increases. The total bit load will still be less than for a bit with large stones
Similar bit with dull stones		Increase pressure over that for sharp stones
Impregnated bit	Hard, fine-grained rocks	Light pressure, never sufficient to slow down the drill. Speeds of 1,500 rpm or over for an EX bit. Slower speeds as bit size increases
Carbon bit	Hard, vuggy, broken ground	High pressure and low speed. Use a slow speed, heavy drill

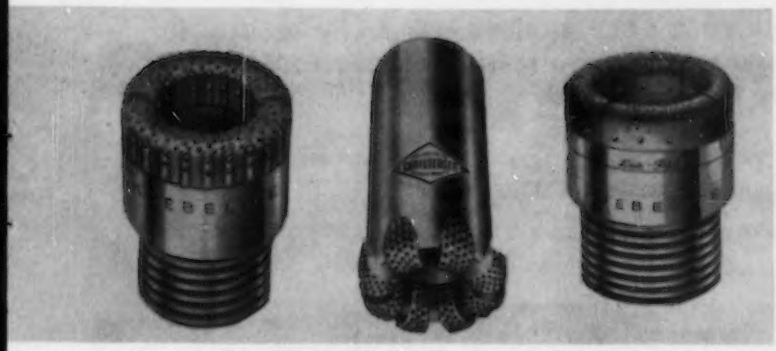
*Diamond Drill Handbook, J. D. Cumming.

Selecting

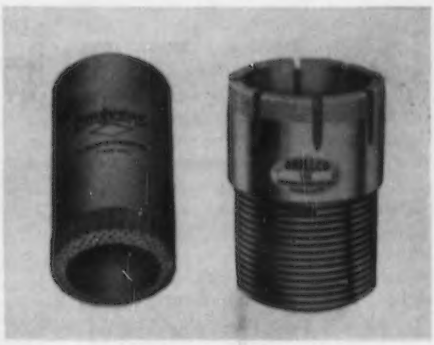
ASIDE FROM THE INITIAL COST of the drilling rig, the most expensive tool used in diamond core drilling is the bit. Thanks to new research in the setting of the diamonds, design of water courses, selection of the best matrix for each type of rock, and increased emphasis on more careful drilling by contractors, diamond core drilling has remained competitive despite recent advances in percussive-rotary drilling using tungsten carbide insert bits. Despite too, the postwar increased cost of industrial diamonds, an increase greater than the average increase in metal prices.

About 95% of the diamonds used in drilling consist of bortz, used for general drilling work including hard rock. Most of the remaining 5% consist of carbons, used particularly for very hard and broken, vuggy ground. Bortz costs from about $6 to $9 a carat depending on the grade, while carbons may cost up to $90 a carat.

Bortz is very hard, with sharp, crystal edges that chip and break rather than polish in use, thus presenting



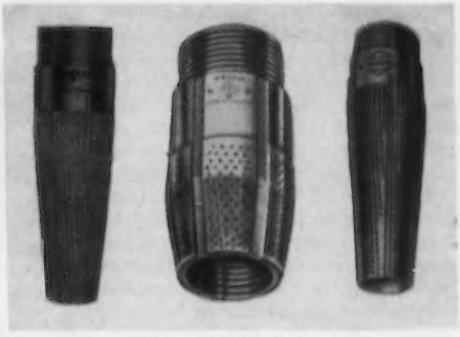
diamond bits, like the second from the right, above, can be used in air drilling.



CASING SHOES AND BITS.

TAPER BITS provide fast drilling in the harder rocks.

REAMING SHELLS between bit and barrel maintain hole gage.



TAPERED REAMERS are used to ream long stretches of hole.

The Right Diamond Bit

fresh cutting edges to the rock, which gives fast drilling, faster than with carbons in ordinary hard rocks. Bortz averages from 16 to 125 stones per carat, with from 60 to 350 stones in an EX bit. Each stone may take about three settings.

Carbons are extremely tough and are therefore best for drilling under heavy pressures in exceptionally hard or broken ground. Carbons are big, averaging only 2 to 3 per carat and an EX bit may contain from 4 to 40 stones.

Using mostly EXT bits in Canada, one report states that diamonds averaging from 18 to 40 per carat give the lowest costs per foot for general drilling. Smaller diamonds 60 to 90 diamonds per carat do well in solid ground under low-powered drills and careful operation, but will not stand abuse, while larger diamonds averaging 8 to 18 per carat do very well in deep drilling under high-powered drills and in broken or soft ground, because they will stand more abuse. Diamond content in an EXT bit with 8 stones to the carat is more than twice as great as, and therefore more expensive than, a bit with 90 to the carat.

For small drills, 7 to 15 stones per carat are recommended for soft, broken rock; 25 to 40 stones per carat for general drilling work; and 60 to 100 stones per carat for very hard solid formations. For large drills, big diamonds of one to seven stones per carat are recommended for drilling sandstones, shale or weathered, igneous rock.

Selection of the proper matrix is essential for best drilling results. If the matrix is too soft and wears away, the diamonds will be over-exposed and fall away, causing considerable damage to the bit. There are three types of matrices in general use: Regular, with a Rockwell "C" hardness of 25 to 30 for hard, solid and non-abrasive rocks such as solid limestone, granite and gneiss; Hard, Rockwell, 35 to 45, for altered rocks, having a sugary grain, or which have been silicified; and Extra Hard, Rockwell 45 to 60, for highly abrasive rocks such as weathered granites, broken quartzite, chert, or flint.

Metal matrix of cobalt bonded tungsten carbide holds exceptionally well in abrasive formations. A beryllium copper cast matrix proves most economical for non-abrasive rocks.

Research work is being done on developing new matrix materials for diamond bits. Ceramics, plastics or even rubber may well prove suitable. Many diamond grinding wheels are bonded with ceramic or plastic materials while the abrasive resistance of rubber-lined pumps and launders is many times that of steel.

Function of waterways in a drill crown is to ensure rapid removal of the rock particles and heat from the diamond cutting points. Excessive water flow over the crown of a bit may cause damaging erosion of the matrix and may lift the bit from the hole bottom, reducing the drilling rate.

Harder rocks need few waterways (not more than two for taconites) to give the greatest diamond concentration with a corresponding great cutting power. In very hard rocks, the walls of the waterways may be reinforced with tungsten carbide. As many as six or eight waterways may be used effectively in soft sandstones and

shales in which clay or bentonite forms the cementing material, more than eight are recommended for sandstone drilling on the Colorado Plateau.

Oriented bits. Postwar research by the Bureau of Mines showed that the life of drilling diamonds could be doubled if they were oriented by hand so that the hard vector direction of the diamond crystal is in opposition to the rock surface being cut. A study of dodecahedral stones set at random showed that only half were properly oriented for efficient cutting.

Nearly all leading diamond bit manufacturers now produce bits with all diamonds over about 80 per carat in size hand set for optimum orientation. One report states that oriented bits saved 42% in diamond cost per foot drilled, while more than doubling the footage drilled per bit.

Maximum bit life can only be achieved by careful attention to operating details:

1. The first 2 in. in a drill hole may cause more wear on a diamond bit than 20 ft of straight drilling, therefore see that an old bit is used to collar holes. Non-coring bits are less liable to damage in collaring holes and diamond loss is less than with coring bits.

2. When lowering the drill tools down a hole, start the circulating water with the bit at least 6 in. from the bottom so as to present a clean rock face to the bit. Always rotate the rods by hand before drilling with power.

3. Since an old bit is slightly under gage, a following new bit should be started up 3 in. or 4 in. from bottom and drilled to bottom. All new bits should be drilled carefully at slow speed for the first few inches.

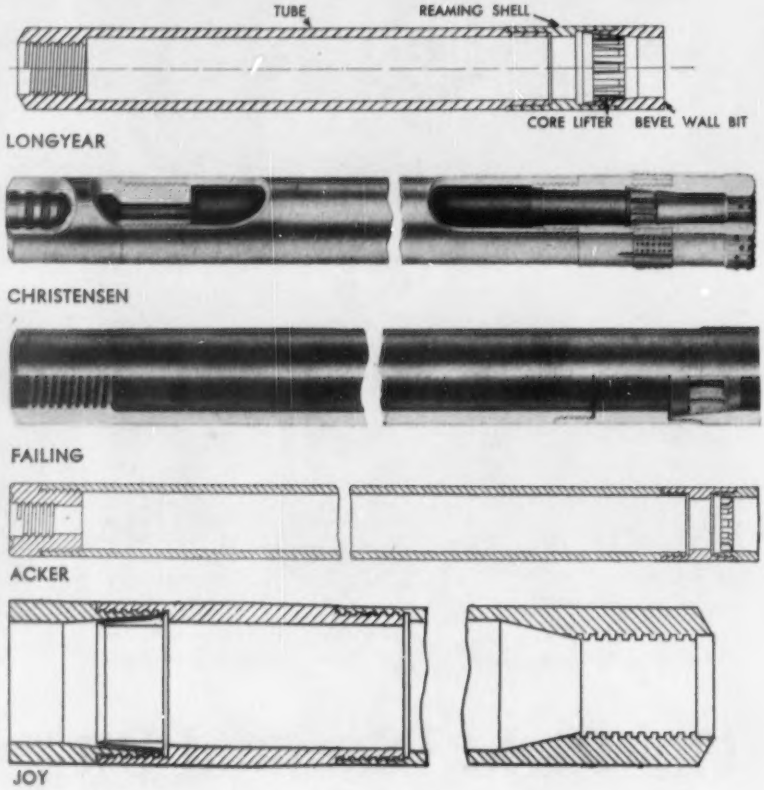
4. Bits that have become polished and therefore ineffectual in a certain rock formation can be re-used in different formations.

5. Diamond wear is reduced as speed of rotation approaches 700 rpm. From 700 to 2,000 rpm diamond wear remains fairly constant, but footage greatly increases.

At Noranda Mines, Canada, a blast hole drill operating at 3500 rpm in sulphides advances 240 ft a shift. Thus the trend is towards higher drilling speeds, which require higher bit pressures to prevent polishing of diamonds, better balanced machines and more rigid mounting. Above all, vibration must be reduced by more efficient design of the drill rig and drill string.

6. When stones become exposed one-third of their size due to drilling in abrasive rock, the bits should be removed and reset, otherwise the stones will fall out of the bit.

SINGLE TUBE CORE BARRELS. Generally used in formations that are easy to core or where maximum core recovery is not essential.



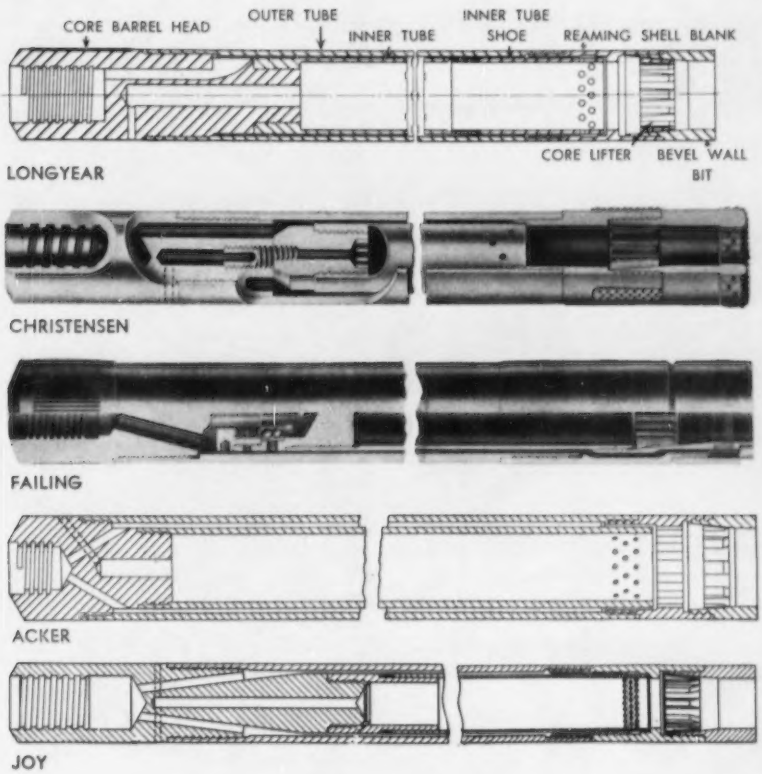
Today's Core Barrels Meet

THE OBJECT of expensive core drilling is not to get rock but to obtain information, the information provided by a core log obtained from a completely recovered core. In many types of ore deposits, a high core recovery is most important since the values may lie in softer rocks, such as sulphides, and it may be precisely these sections that are missing from a core box. For example, in a 500 ft hole a 2% core loss is 10 ft of core and may be mainly from soft, sheared vein material that might well contain valuables—in a core box, core can easily be "stretched" to cover shortages.

When core recovery falls below about 85%, it is essential to find out by sludge samples the exact composition of the losses and to compare these with core samples. Many companies request the field geologist or sampler to empty core barrels themselves, at least the more critical ones. If the losses are important, it may be necessary to improve core recovery either by using a more efficient core barrel, or by taking larger diameter core samples, or both. As a last resort, it may be necessary to take sludge samples, although since they do not provide precise geological data, they are not recommended except for massive deposits where information as to the precise location of bedding planes is not essential. Moreover, sludge samples are liable to contamination due to caving from the sides of a drillhole.

Not all the people concerned with diamond drilling have the same objectives. The client, of course, wants the best possible core recovery; the drilling contractor guarantees a certain minimum core recovery, generally around 85%, but is primarily interested in footage and in low costs; while the drill runner, aiming for bonus, is interested solely in footage.

DOUBLE TUBE CORE BARRELS, RIGID TYPE. Water passes between inner and outer barrels, hitting the core only at the bit.



Tougher Trials Than Ever

Consequently, any drill program demands constant and careful supervision by the client's representative to ensure that the best possible core recovery is consistently obtained.

There are several causes of poor core recovery:

1. In softer rocks, excessive water pressure may erode the core within the barrel — besides reducing drilling speeds.

2. Excessive vibration and bit chattering; caused by high drilling speeds, old drilling machinery, rods that are undersize for the hole being drilled, rods that are worn, bent, or out of balance, and insufficient rod grease.

3. Starting up the drill string at excessive speeds after each rechuck; thus causing violent torque and consequent torsion fractures on the core already in the barrel.

4. Overdrilling a run; causing grinding at the bottom of a hole.

5. Dropping a part of a core and grinding it in the hole. Any core dropped or left in a hole should be removed or it may cause damage to the diamonds when drilling is resumed. If the core cannot be lifted from the hole, a cross chopping bit is used to break up the core so that it can be washed out of the hole.

Single tube core barrels are effective only under the best possible coring conditions, but are often used where speed is more important than core recovery. They are standard in light exploratory drill rigs where the small hole diameter drilled necessitates the thinnest possible core barrel in order to leave an adequate core diameter. The core barrel may be fitted to a bevel bit and a core lifter, or to a straight wall bit without a core lifter. With the bevel bit and core lifter the core is mechanically held in the barrel upon blocking, whereas the straight wall bit must be dry-blocked (by running for a few seconds without water) so that the cuttings may wedge the core into the barrel for lifting out of the hole. Since dryblocking may damage the diamonds, most drilling today is with bevel bits and core lifters. The bevel bit holds the diamonds more securely on its rounded faces and can drill faster in hard formations; the straight wall with its flat face is easier to set, has fewer diamonds and is therefore cheaper.

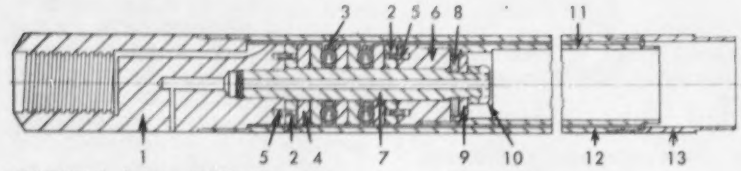
Rigid double tube core barrels are designed to improve core recovery by reducing the danger of core being washed away as the return water and cuttings pass up inside the barrel. In this assembly the water flows up between the inner and outer barrels, which are connected and rotate together. This type core barrel is used for average drilling conditions, and is available in all sizes except the smallest. In abrasive ground an outer tube may be faced with stellite, providing considerably greater life at comparatively small expense.

Ball bearing swivel type double tube core barrels are used in more difficult ground. The inner tube is mounted within the outer tube on enclosed ball bearings so that it can rotate independently, thus reducing the possibility of disturbing the core as it enters the barrel.

For particularly bad ground, special-type double tube swivel core barrels have been developed recently, which successfully raised core recoveries from between 20% and 40% up to 80% and 95% in soft friable hematite ores and, in the larger sizes, have even been able to extract undisturbed soil samples. Known as the Pickard core barrel by the E. J. Longyear Co., and the Series M barrel by Sprague & Henwood, these special barrels feature 1) a swivel type inner tube that remains stationary while the bit and outer tube revolves; and 2) an inner tube extension and a box thread bit allowing the inner tube extension to reach practically to the stones in the end of the bit, thus eliminating most of the eroding washing action of the circulating water on the core. The core lifter is screwed into the non-rotating extension and avoids disturbing the core as it enters the barrel. Although replacement cost is higher than with conventional barrels, the cost per foot of sample obtained may be lower, and in difficult ground, it may be the only means of adequate core recovery.

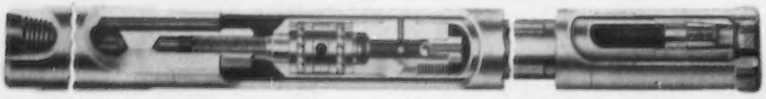
In general, for the best possible core recovery in hard rocks, drill with low bit speeds and heavy pressure on the bit; in soft rocks, use high speeds and low pressure.

DOUBLE TUBE CORE BARRELS, SWIVEL TYPE. Because the inner barrel may remain stationary as outer barrel rotates, better core recovery can be realized.

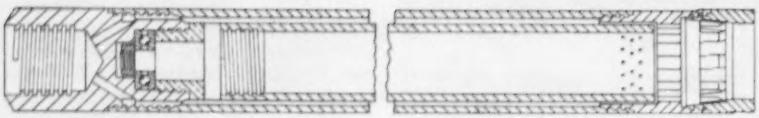


LONGYEAR (BALL BEARING)

1. Outer tube head
2. Wear washer
3. Ball thrust bearing
4. Bearing spacer
5. Taper pin
6. Inner tube cap
7. Spindle
8. Bronze washer
9. Steel washer
10. Jam nut
11. Inner tube
12. Outer tube
13. Reaming shell blank



CHRISTENSEN



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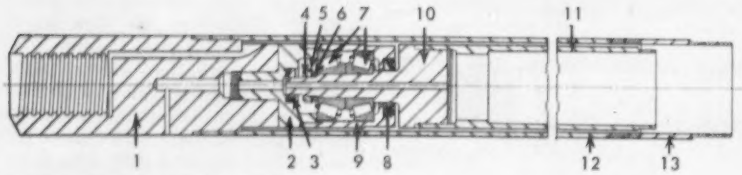
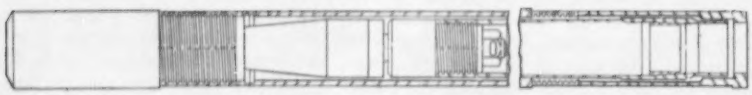


LONGYEAR (ROLLER BEARING)

1. Outer tube head
2. Housing cap
3. Garlock Klozure
4. SKF lock nut
5. SKF lock washer
6. Bearing spacer
7. Timken roller bearing
8. Garlock Klozure
9. Bearing housing
10. Bearing shaft
11. Inner tube
12. Outer tube
13. Reaming shell blank



JOY

Wire Line Core Barrel

After nine years of operation in oil drilling, the wire line core barrel is today being successfully employed in comparatively small mineral exploration holes down to BX size, 2⅜ in. hole diameter with 1⅛ in. core diameter. The rig has given higher core recovery, faster drilling and lower diamond costs in holes of all depths, ranging from a few hundred feet to several thousand feet, and has proved particularly economical for drilling in badly fractured ground.

The operating principle of the wire line equipment is shown in the accompanying diagrams. The basis of the idea is the positive latching mechanism that ensures proper positioning of the inner tube when the tube is dropped into place. When a core blocks, the drill string is lifted until the top joint is conveniently above the swivel head. The hole is flushed or water circulation maintained as necessary. The top rod section is removed and the overshot assembly lowered down inside the rods to engage the spear of the inner tube assembly. This is hoisted from the drillhole and detached, a spare tube, already serviced and assembled, is dropped or lowered into the drill string and drilling can be resumed immediately.

The new inner tube can be dropped free into the drill string if the drilling fluid is less than 100 ft below the collar of the hole, otherwise it is lowered on the wire line. Dropping speed is about 200 fpm dropped freely through water, and 400 to 600 fpm lowered on the line in dry holes. Where necessary in holes over 700 ft deep, the tube is pumped down, its descent being speeded by rotation of the drill string. Indication that the tube is in place is given by a sharp increase in the pump pressure or by the sharp shock produced in the drill string upon contact.

Advantages of the wire line core barrel:

1. The diamond bit and the drill string remain in the drillhole until the bit has to be replaced, consequently the best possible bits having a maximum penetration and life are employed.

2. Since the drill string is pulled much less frequently than in conventional drilling, there is considerably less caving, which improves the bit life and reduces the danger of premature blocking.

3. Core barrel is more sturdily built than conventional barrels.

4. Less manual effort is required since the drill string only has to be withdrawn when it is necessary to change a bit.

5. Short core runs may be made where required in difficult coring ground without excessive time loss.

6. The equipment can be employed with either screw or hydraulic feed drill heads.

7. Clinometer survey tests can be made quickly using the wire line inside the drill string.

The core barrel used with this equipment is of the new double-tube, ball-bearing swivel type with an inner tube extension bringing the nonrotating inner tube and core lifter right down to the face of the bit for maximum core recovery.

Wire line equipment can be used in all types of rock formations; the Southwest copper deposits, the Midwest sedimentaries or the Precambrian formations. In 75,000 ft of vertical and angle holes from 400 ft to 4,000 ft deep in all types of rock, the average core recovery was 94.01%. In a typical instance of a 1500-ft hole drilled through cherty limestone, a coring cycle took 1 hour and 21½ minutes versus 2 hours and 25 minutes with conventional equipment at the same depth in the same area.

How the Wire Line Core Barrel Works

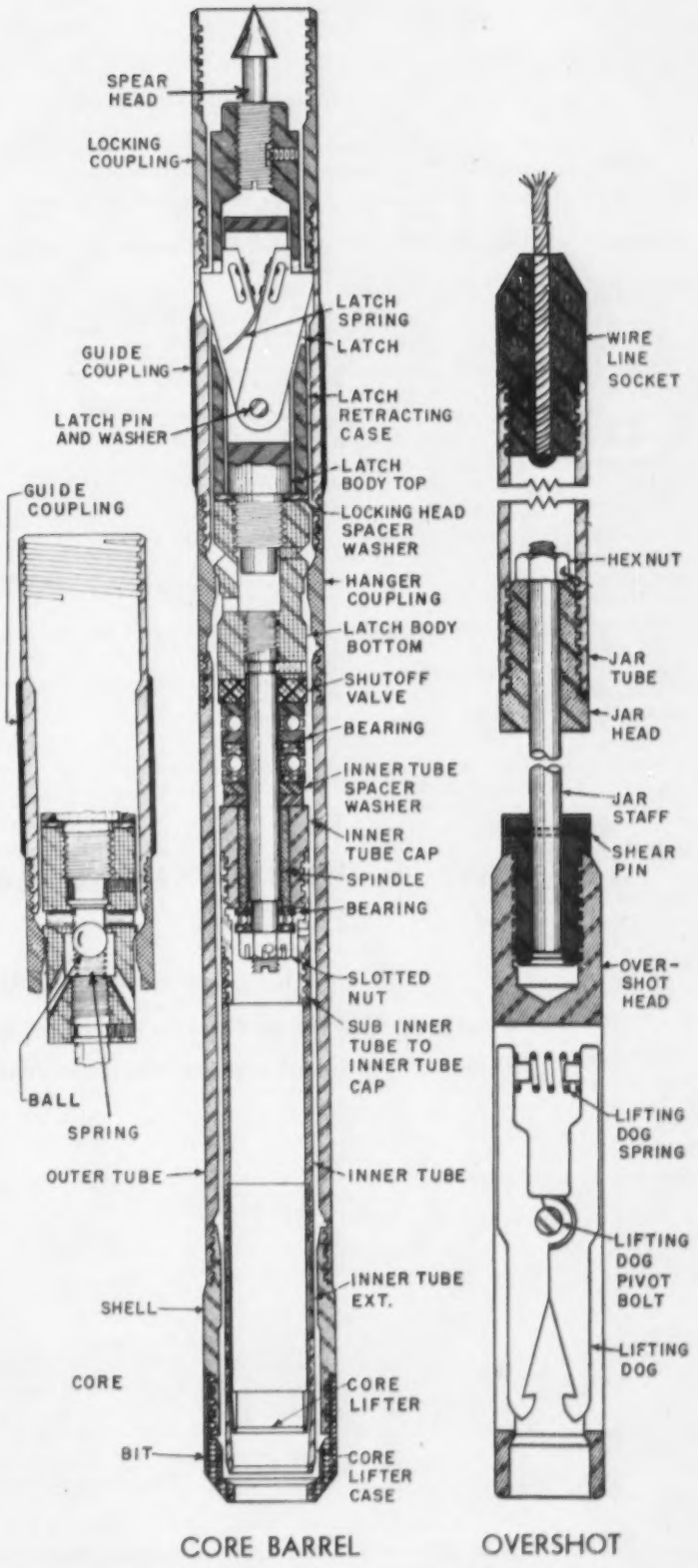
WHEN THE CORE has filled the inner tube of the barrel, or when a core "block" develops, drilling is stopped and the drill string raised slightly so that the top joint is in a convenient position for "breaking." The hole is flushed, and the top drill rod removed. The overshot assembly is then lowered on the wire line through the drill rods. The lifting dogs of the overshot assembly hook on to the spear head of the inner tube assembly. By pulling up the wire line, the latches that lock the inner tube assembly in position retract, and the core-retaining inner tube may be pulled out of the hole through the drill string which remains in the hole.

As soon as the inner tube assembly is out of the hole, a second standby assembly can be dropped through the drill rods if the hole is full of fluid. By keeping his hand on the drill rods, the driller can "feel" when the descending inner tube is seated and locked in the outer tube assembly. With the inner tube thus locked in, coring can be resumed. Speed of rotation may vary from 300 to 1,000 rpm depending on conditions.

In deeper holes, let us say deeper than 700 ft, water circulation can help to pump the descending inner tube into position. This is also recommended for angle holes which have been drilled as flat as 30 deg from the horizontal. If the inner tube assembly is pumped in, the seating will be indicated by a sharp rise in pressure.

If the drill hole is dry the fast descent would act destructively on the equipment. In dry holes, therefore, the inner tube assembly is lowered with the overshot on the wire line at a rate of about 300 fpm.

An optional feature of the Longyear wire line core barrel is a simple water shut-off valve that immediately alerts the driller to a core block. It consists of a rubber washer that is squeezed by the core block, thereby filling the annular space between outer and inner tubes. This causes the pump pressure to jump and the driller knows he has a core block. Simple but effective, the shut-off valve helps increase core recovery, lower diamond losses and reduce wear on the inner tube assembly. This extremely important feature of the wire line core barrel is responsible to a very large degree for its success. However, with the water shut-off device, a closed pumping circuit must be used.



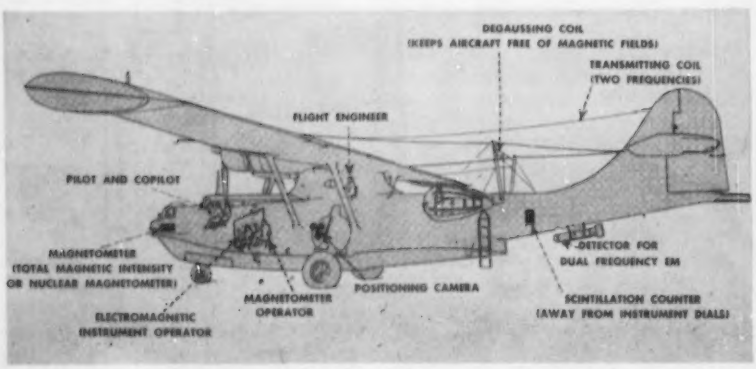
Geophysical Exploration

Listed in order of increasing resolving power

Method	Field of force	Operating principle	Controlled penetration depth	Applicable to drill-hole logging	Survey Costs	
					Airborne	Ground
(1) Geothermal	Earth temp. gradients	Measurement of thermal conductivity	No	Yes	Ground only	$100 to $150/line-mile $500 to $750/month
(2) Magnetic	Earth's magnetic field	Measurement of magnetic permeability	No	No	$6 to $10/ line-mile	$110 to $150/line-mile $500 to $750/month
(3) Seismic: Reflection	Artificially created seismic waves	Measurement of velocity of reflected wave transmission, as affected by density, elasticity, formation boundaries	Yes	Yes, using shortholes	Ground only	$6,000 to $11,000/month
Seismic: Refraction	Artificially created seismic waves	Measurement of velocity of direct seismic waves	Yes	Yes, using shortholes	Ground only	$6,000 to $15,000/month
(4) Gravitational: Gravimeter Pendulum	Earth's gravitational field	Measurement of gravity in vertical direction	No	No	Ground only	$3,000 to $5,000/month
Gravitational: Torsion Balance	Earth's gravitational field	Measurement of gravity in horizontal direction, for both magnitude & direction	No	No	Ground only	$3,500 to $4,500/month
(5) Geochemical	—	Surface soil, water & gas analysis	No	No	Ground only	$3,000 to $6,000/month $200 to $500/sq mile
(6) Radioactivity	Radiation	Measurement of radioactive differences in rocks	No	Yes	$6 to $10/ line-mile	
(7) Electrical: Self-potential	Natural potential fields	Measurement of spontaneous polarization of rocks	No	Yes	Ground only	$105 to $135/line-mile $2,000/month $1,000/sq mile
Electrical: Resistivity	Artificially created electric field	Measurement of electrical resistivity	Yes	Yes	Ground only	$125 to $175/line-mile
Electrical: Electromagnetic	Artificially created electromagnetic field	Measurement of electrical conductivity	Yes	—	$10 to $20/ line-mile	$2,000/sq mile $3,500/month

How Geophysical Techniques Save

Speed and the need to "see" more and more of what lies beneath the earth's surface are the goals of modern geophysics. Described here are the tools doing that job today.



AIRBORNE GEOPHYSICAL LABORATORY combines radiation detection with magnetic and electromagnetic techniques plus aerial photography for faster surveys.

ULTRA VIOLET LIGHT detects fluorescent minerals. (Unit is Mineralight.)

Techniques

Application
Shape of intrusive bodies; contacts between sedimentary and igneous (or different sedimentary) rocks; faults; groundwater distribution and flow; zonal distribution of ores
Iron and nickel orebodies; Pyrrhotite and assoc. sulphide ores; ilmenite; gold placers; faults; anticlinal structures; ridges; intrusive bodies
Anticlinal structures; faults; depth of bedrock; salt domes
Low dip structures; faults; depth to bedrock; buried channels
Structural trends; buried ridges; salt domes
Anticlinal structures; buried ridges; faults; intrusions; salt domes
Trace elements; mineralization
Uranium, thorium orebodies; pegmatites (due to radioactive potassium in acidic granites); faults
General formation boundaries; bedrock depth; sulphide orebodies, except sphalenite; magnetite; cobalt; graphite; anthracite; oxidising orebodies at depth
Sulphide and oxide orebodies; water; oil; sand; gravel, depth of overburden
Sulphide orebodies; graphite

Exploration Dollars

GEOPHYSICAL PROSPECTING has now come of age in the mining industry. It is being used in both large and small scale exploration programs, carried out in the air or on the ground, by exploration company personnel or by contract surveys, in all aspects of mineral exploration from the location of a new mineral district to the extension of a producing mine.

Geophysical prospecting strives to determine the existence, position and boundaries of potential orebodies and geological structures by measuring small local differences in the physical properties of the earth's crust. Referred to as anomalies, these differences, listed in order of increasing resolving power, may be differences of temperature (geothermal), magnetic susceptibility (magnetic), elasticity (seismic), density (gravitational), quantity of entrained trace elements (geochemical), radioactivity or electrical differences such as spontaneous polarization (self-potential), resistivity and conductivity (electro-magnetic).

In planning a geophysical survey, an experienced geophysicist applies several methods to the same problem to obtain confirmatory interpretations depending on different physical properties of the same geological feature. Here is a quick check on where and how these methods are used.

Geothermal

Temperature measurement has been used extensively in oil exploration to determine the configuration of intrusive bodies, contacts between sedimentary and igneous rocks, faults and anticlines. In mineral exploration it will often give useful information on the zonal distribution of ores.

Equipment consists of a galvanometer, potentiometer and special thermocouple with an electromotive force of about 40mv per deg C and a sensitivity of 0.01 deg C. Readings are corrected for near-surface daily and annual temperature variations due to the sun, and for depth variations due to the temperature gradient of the earth.

Cost is between $100 and $150 per line-mile or $500 to $750 a month with two operators making near-surface temperature measurements in short auger-driven holes or deep measurements in drill holes.

Magnetic

Since its first use in 1640 to find iron ore in Sweden, the magnetic compass has become the most popular geophysical prospecting tool. Its unique value lies in the fact that it is both a direct and an indirect exploration tool—direct in that it shows up magnetic bodies such as magnetite, ilmenite and nickel; and indirect in that a sensitive magnetometer can detect anomalies due to structural distortions and inhomogeneities of composition in the rocks below, thus tracing faults and structural geological features beneath overburden. Basic rocks, for instance, are more magnetic than acidic, and plutonic more than sedimentary. In the Keweenaw Peninsula, copper deposits are known to be localized in flow tops of certain tilted Precambrian basalt flows, which produce large magnetic anomalies. Tracing these basalts by magnetometer surveys revealed favorable areas for prospecting.

Magnetometer surveys measure changes in direction and intensity of the earth's magnetic field in the horizontal plane (declination), and in the vertical plane (inclination). In a dip needle magnetometer, the inclination is measured with a balanced needle swinging vertically in the plane of the magnetic meridian, as determined by a second, horizontally mounted needle. The latest magnetic field balance used for ground surveys weighs about 14 lb, has a sensitivity of 20 gammas, and may be used to determine either the vertical or the horizontal magnetic component.

During World War II, the flux-gate continuous-recording magnetometer was developed for use in airborne and truck surveys. The earliest was the Gulf magnetometer, which used a fast-acting servo-mechanism to orient the magnetic element into the earth's maximum magnetic field, thus recording total intensity rather than any directional component.

The latest equipment for airborne surveys is the Varian magnetometer based on nuclear induction. Polarized protons are caused to precess in the earth's magnetic field and the frequency of precession is a measure of

MAGNETOMETER. Gulf Research and Development Co.

GRAVITY METER. Houston Technical Laboratories.

GEOCHEMICAL SOIL TESTING.

ELECTRICAL RESISTIVITY. Geophysical Instr. Co.

SEISMIC REFRACTION SYSTEM. Houston Technical.

REFLECTION SEISMOGRAPH SYSTEM. Detailed coverage at medium depth. Houston Technical Laboratories.

SEISMOMETER. Houston Technical Laboratories.

the field. This instrument records total intensity to a sensitivity of 0.25 gammas.

Cost of airborne magnetometer surveys runs from $6 to $10 per line-mile, excluding interpretation, which the contractors will usually undertake if required.

Airborne magnetometer surveys minimize the near-surface distortions of ground surveys and are fast, covering in one month an area that would have taken a ground crew 80 months to complete. Bethlehem's blind orebody in eastern Pennsylvania was found as a result of a 900,000-acre airborne magnetometer survey that was flown in 30 days. The 2-in.-to-1-mile maps showing magnetic contours 10 gammas apart were completed in four months for a cost of only 7c per acre, or $45 per square mile. Flight lines were ¼ mile apart, at right angles to the regular strike of the main geological features.

On another large iron deposit found by airborne magnetometer surveys over Marmora, Ontario, probability studies of flight-line spacing showed that there was a 35% chance of locating that orebody with flight lines one mile apart; the probability improved to 70% with ½-mile intervals and 90% with ¼-mile intervals between flight lines.

Seismic

Seismic exploration has been widely employed in the oil fields because of its unique success in measuring the depth of extensive, flat, stratigraphic horizons. The technique is not so applicable to studying the small, nearly vertical discontinuities encountered in the usual metalliferous vein deposit, but is useful in depth of overburden studies.

Seismic techniques measure the time interval between the shock propagation and the arrival of compression waves at a number of near-surface stations, after the waves have been reflected or refracted at surfaces of discontinuity. Reflection methods, made possible by improved sensitivity of recording equipment, have superseded refraction methods because of their greater simplicity and smaller consumption of explosives.

New high frequency (30 to 500 cycles per second) seismic reflection equipment is being successfully used in iron exploration to determine depths of overburden with a depth range of 75 to 5,000 ft and a high resolving power. New magnetic tape recording gear permits seismic data to be stored easily, and to be played back under varying filtering controls.

Impact weights of 3 tons or more are replacing the usual dynamite shot. Professor Ben Howell of Penn State reports that 700 ft-lb of impact energy produce a shock wave 1/10 to 1/100 as strong as that produced by ½ lb dynamite exploded at a depth of 10 ft.

Cost of operating a seismic shot crew in the field runs from $6,000 to $15,000 a month including shot-hole drill rig and crew, recording equipment and crew, surveyors and supervision. There are no reports available on the costs of shallow impact equipment used in mining, but they are likely to be considerably lower than the deep seismic surveys carried out by the oil industry.

Gravitational

Long used in the oil fields to trace low density salt domes, gravitational

GEIGER COUNTER. Universal Atomics Corp.

GEIGER COUNTER. Precision Radiation Instr., Inc.

GEIGER COUNTER. Curtis-Wright Corp.

DRILL HOLE COUNTER. Electronic Associates, Ltd.

DRILL HOLE COUNTER. Mount Sopris Instr. Corp.

SCINTILLATION CTR. Electronic Associates, Ltd.

SCINTILLATION CTR. Atomic Energy of Canada, Ltd.

SCINTILLATION CTR. Precision Radiation Instr., Inc.

techniques are now finding application in the mining industry to trace geological structures, large dense bodies such as chert, iron, hematite or massive sulphides, and large light bodies such as salt deposits. USGS gravity surveys in the Camaguey Province of Cuba for chromium ore showed eight likely anomalies; subsequent core drilling found three to be orebodies with a total of 250,000 tons of shipping grade refractory chromite ore.

The latest field gravity meters are extremely sensitive, to about one 0.01 milligals (one milligal equals one-millionth of the total gravitational pull at the surface of the earth) and readings can be taken in three minutes. Readings have to be corrected for elevation of the instrument, for terrain and for movement of the sun and the moon.

Early instruments employed the torsion balance or the pendulum, to measure vertical components of gravitational force. Both types are still used for absolute measurements at base stations. Modern field equipment measures the differences in length of a coiled spring by optical and mechanical devices; they weigh about 6 lb and about sixty stations can be measured a day without difficulty.

Geochemical

Modern geochemical techniques study the dispersion patterns of trace minerals to determine (1) the presence and nature of any abnormal mineral concentration; (2) the more favorable areas for more intensive exploration or (3) mineralization, if any, present in an anomaly discovered by some other geophysical method.

Rapid reconnaissance of soil mineralization will show the presence of a particular mineral, though not necessarily its absence. The technique works best in shallow-covered areas of residual soil where the bedrock concentration is above the water table.

Geochemical soil sampling in the Mississippi Valley, Tri-State district, is now used to eliminate unlikely areas for core drilling. The Tri-State orebodies occur in comparatively small centers of intense structural deformation in an area of 2,000 sq miles. These were generally explored by semi-wildcat drilling on ¼- to ½-mile centers at a cost of $5,000 per sq mile against $200 to $500 per sq mile for soil sampling (average cost $1 per sample). Samples are taken by a three-man crew every 50 ft on lines 100 ft apart. Heavy metal content is determined in the field colorimetrically. The three-man crew collects and assays an average of 45 samples a day.

In the weathering zone, rocks and minerals are broken down and part taken into solution and carried away by ground waters. Consequently the soil and waters around bedrock mineral concentration will contain abnormal concentrations of the mineral, decreasing with distance, in the form of dispersion halos, fans or trains depending on the topography of the area.

In order of accuracy of the sample, geochemical samples may be taken of bedrocks, overlying soils, ground and stream water, or vegetation. The samples are taken at regular intervals and by identical methods for each particular survey on a grid pattern, with closer intervals across the strike.

Soil samples from unmineralized areas might contain under 100 parts per million of copper, zinc or lead, while soils from mineralized areas may contain over 10,000 ppm of the

DRILLHOLE COUNTER logs radioactive horizons in drill holes, thus saving coring except for correlation purposes.

AIRBORNE MAGNETOMETER, responsible for several important mineral discoveries, speeds modern exploration.

base metals, indicating target size.

T. S. Lovering, USGS Geochemical Exploration Chief, reports that USGS practice is to take the threshold of significance of a geochemical anomaly to be twice the background value, and that the significance of geochemical contour lines is best expressed in geometrical multiples (2, 4, 8, 16, etc.) rather than arithmetic multiples (2, 3, 4, 5, etc.) of the background values. He points out that a geochemical anomaly running 2500 ppm of lead in contrast with a background count of 20 ppm is impressive, but is still only 0.25% lead and not yet ore. USGS geochemical surveys to date show that twelve or more noncommercial mineral deposits will be found for every one of major importance.

Water samples may be collected from stream or ground waters, but they cannot be compared since ground waters will normally contain higher mineral values than running waters flowing in open channels. In stream waters, the background count may be under 0.001 ppm where no base metals are present to 7 ppm in waters draining from areas containing base metal concentrations.

Geobotanical surveys may study accumulator plants that absorb certain minerals present in the underlying soil and bedrock, or indicator plants that show strong preferences for areas where certain minerals are abundant but are not taken up by the plants themselves. Accumulator plants bring up certain mobile minerals from depths to 75 ft. Sampling should be carried out at regular intervals using similar parts of the same species of plant. A second-year twig gives optimum sampling results.

Indicator plants, which vary in each mineral province, are associated with certain minerals and with certain stratigraphic horizons. In Rhodesia, for instance, granites beneath overburden can be recognized by the crisscrossing lines of trees probing joints in the rock.

Extent of the famous Cerro Bolivar iron deposit in Venezuela was determined by tracing the Clusia Rosea, a plant 20 to 50 ft high with horizontal branches and white to pink flowers that could be recognized easily in air photos. Geobotanical studies have led to the discovery of uranium deposits by the USGS in the Colorado Plateau; also to the discovery of tin and tungsten in Cornwall, England, and tungsten and vanadium-bearing shale in Sweden.

A geochemical survey should be simple, rapid and cheap, demanding fair precision rather than excessive accuracy. A preliminary orientation survey should always be run to check the method and interval of sampling required for any new area. The sampling interval may vary from ten to hundreds of feet depending on the size of the target. For preliminary reconnaissance of an unknown district it is standard USGS procedure to concentrate first on streams and their alluvial deposits to pick out favorable areas for more intensive study as quickly and as cheaply as possible.

Because geochemical samples contain a great deal of bulk for a minute content of metal and because a great number of samples are required for a complete geochemical survey, simple, foolproof assay methods are required for prospecting crews in the field.

The USGS Geochemical Section has been concentrating on rapid and sensitive analytical methods for determining trace elements in rock, soils, plants and water. They have published methods for determining traces of Cu, Zn, Pb, Ni, Co, As, Sb, W, Mo, Ag, Nb, Ge, Va, Ti, Fe, Mn, S and P. Their current work on determinations of uranium and bismuth are virtually perfected and they hope to perfect methods for chromium and mercury shortly. To spread the application of these methods the section operates training courses on both laboratory and field techniques.

Spectographic analyses are particularly useful for geochemical exploration since they permit low cost qualitative and semi-qualitative assays for many elements at once. Spectographic analysis is based upon the fact that all atoms produce radiation when suitably excited. Radiation patterns for each element are as characteristic as a fingerprint and intensity of the pattern is proportional to the number of atoms present.

For field use the USGS has developed a truck-mounted spectographic laboratory. After being driven 525

miles to a field project in Utah, it was ready to operate two hours after arrival. A trailer carries a power generator and a second truck contains crushing and grinding equipment. The USGS also has developed ceramic grinding equipment that is as hard as steel and eliminates contamination of the sample.

Radioactivity

Radiation surveys, developed in the search for uranium deposits, are now showing promise of detecting structural features, faults and contacts between igneous and sedimentary rocks. This is because certain isotopes of acidic granites, notably potassium, are radioactive enough to be detected by sensitive equipment. Radiation surveys in Manitoba with a scintillometer showed radiation count increases of from 8 to 10 times the background count in passing from basic rocks to granites, and the increase was still greater over pegmatite dikes due to additional radioactive elements.

A rock is radioactive when certain elements, particularly uranium, disintegrate into a series of different radioactive elements, giving off breakdown energy in the form of alpha and beta particles and gamma rays. The most penetrating of these, the gamma rays, can be detected by sensitive geiger and scintillometer counters if they are close enough—within a comparatively few feet of a radioactive outcrop for the smaller geiger counters, to 400 ft for the most sensitive airborne scintillometer equipment. Gamma rays lose half their intensity passing through 400 ft of air, are reduced 20% passing through ½-in. steel and are stopped completely by 12-in. barren sandstone or 30-in. water.

The geiger counter consists of a glass tube containing an inert gas and two electrodes. A high voltage supplied to the tube is insufficient to overcome the resistance of the gas except when the gas becomes ionized by a gamma ray striking the cathode causing a pulse of current to flow between the electrodes. This pulse of current is amplified and registered by a ratemeter showing the number of pulses per minute on a numbered dial. Geiger counters are light, with small batteries and, with a sensitivity up to about six counts per second, and are quite adequate for ordinary reconnaissance.

For detailed radiation surveys a more sensitive instrument of about 40 counts per second is required. This is provided by a scintillometer with a thallium activated potassium iodide crystal, 1 in. in diameter. The scintillometer crystal emits light when struck by a gamma ray, the impulses being converted and amplified into electrical impulses in a photo-multiplier tube and recorded on a ratemeter. The scintillometer is considerably more sensitive than the geiger counter, but not so robust. It is heavier, due mainly to the heavier batteries required.

Truck - mounted scintillometers should have a sensitivity of at least 85 counts per second when they can be employed at speeds up to 30 mph. Mounting 5½ ft high on the truck gives a radial coverage of about 30 ft. Ground surveys are sometimes misleading due to the mass effects of a large volume of slightly radioactive rock. Rock samples should be taken to a place showing nothing but background count and the sample rejected if it is not more than two or three times the background. Such mass effects of weakly radioactive rock is particularly troublesome in the Canadian shield. An increase of 20 to 30% in the count-rate indicates an increase of approximately 0.001% of U_3O_8 in the bedrock.

Gamma logging of drillholes is useful for three reasons: (1) in the ore horizon a scintillometer that has been calibrated against a core assay will give a fairly accurate estimate of ore grade; (2) it can extend and correlate formations between drillholes up to 100 ft apart; and (3) it can estimate the thickness and general type of formation. In general, holes must be over 1¼ in. in diameter for geiger counter logging, and over 2 in. in diameter for more accurate scintillometer logging.

Airborne radioactivity surveys are carried out with the scintillometer head in a cylindrical lead shield so that a 45 deg downward cone is viewed by the instrument. A 35mm strip camera records the flight lines and a radio altimeter records the height of the plane above the ground. Grid flying is carried out at altitudes of 100 to 200 ft which allows a coverage of 100 to 200 ft on each side of the plane. Costs vary from $4 to $6 per line-mile.

In uranium exploration on the Colorado Plateau, AEC geophysicists report rimflying to be the most economical and productive. The plane used should have a service ceiling of 15,000 ft, a useful load of 1,000 lb, stability at low air speeds of 50 mph, a cruising speed of 120 mph, a high rate of climb and good visibility. The scintillometer used should have a fast, ½-second response and a sensitivity of over 200 counts per second obtained by a crystal of 3-in. diameter. Flying should be carried out within 300 ft of outcrops, a distance of 100 ft is preferred. AEC flying costs averaged $3,000 per plane per month, giving 70 hr in the air per month and 3,000 miles of rim flying, a cost of $1 per rim-mile.

Self-Potential

Certain metallic bodies generate spontaneous electrical currents in contact with mildly acid solutions in a weathering zone near the surface and with mildly alkaline solutions from the rock minerals at depth. Direction of the current is down the metallic body to depth, out into the wall rocks back to the surface where it completes the circuit by flowing back into the apex of the body. Such bodies are mainly massive sulphides (except sphalerite), graphite, and to a lesser degree anthracite coal, some manganese oxides, cobalt and magnetite. Anomalies found by self-potential surveys are followed by geochemical or other geophysical techniques to determine what mineralization might be present in the body. Under certain conditions formation boundaries and geological structures act in a similar manner.

The detection of these buried conductors can be simple and rapid since the inflow of current causes a negative center of potential difference above the apex of the deposit, showing a voltage from 0.1 to 0.7 volts. These potentials are measured by a millivoltmeter-potentiometer connected to a pair of non-polarizing electrodes consisting of copper bars set in a saturated solution of copper sulphate in unglazed earthenware pots. One electrode remains on the ground at a base point while the other, connected by 1,250 to 1,800 ft of wire, is moved about on a grid pattern. Readings are taken every 50 or 100 ft, along traverse lines 50 to 400 ft apart depending on the size of the target sought. The pots must be placed on fresh earth, not on decaying humus which may introduce false potentials.

Strength of the potentials generated depends primarily on the sulphide concentration in the deposit, and not at all on the width of the body. A minimum concentration of 5% is necessary for interpretive readings above the body. Increasing thickness of overburden reduces the surface potential, and readings cannot be interpreted when the overburden is more than about 300 ft thick.

The technique was successfully employed with resistivity and electromagnetic surveys to find new orebodies at the Matsuo Mine in Japan

(where vertical shafts were found to give negative centers similar to those above sulphide orebodies). At the Buchans Mine in Newfoundland, potential difference and resistivity surveys of drillholes found a conductive body which subsequent drilling proved to contain 700,000 tons of ore.

Self-potential surveys take only 5 minutes per reading and require no generator, thus are rapid and inexpensive. Cost per line-mile, using two operators, varies from $105 to $135, depending on the amount of line-cutting involved. Equipment costs from $550 to $800, with the latter figure buying a vacuum tube voltmeter which can also be used for resistivity surveys.

Resistivity

Virtually all rocks have pore spaces containing water with salts in solution, the amount depending on the type of rock and its compaction. The greater the porosity of a rock the smaller its resistivity, which provides a means of distinguishing between certain rocks below ground since variations in resistivity are often accompanied by variations in lithology.

Sulphide bodies, graphite and materials with a high water content such as sand, gravel and overburden, have a high electrical conductivity, thus can often be distinguished from more compacted surrounding and base rocks. Further, variation of the spacing between the electrodes supplying the current controls the penetrating depth of the survey, which makes possible the determination of the approximate depth of overburden or of a gravel bed.

Rocks of the Precambrian Shield have resistivities ranging up to 100-million ohm-cm, while at the other end of the scale, saline shales exhibit resistivities of under 100 ohm-cm. In general, igneous rocks have higher resistivities than sedimentaries but, depending on the compaction, a ten-fold variation may be encountered within one rock type. Apparent resistivities are lower in areas of increased porosity, shearing and brecciation, giving some indication of fault zones.

Resistivity surveys are usually accomplished by passing a direct current or a low frequency (100 to 500 cycle) alternating current between two energizing electrode stakes, and measuring the potential difference between two or more auxiliary electrodes placed at other points in the area under investigation.

Power is generated by means of a portable gasoline generator having a capacity of 1,000 to 2,000 watts, enough to generate a measurable current between the two stakes. For ease of interpretation, all the electrodes are generally placed in a straight line along a traverse across a known strike. Drillhole resistivity surveys are carried out by lowering an auxiliary electrode down the hole.

Costs of resistivity surveys run from $125 to $175 per line-mile, greater than self-potential surveys because of the extra equipment and the minimum three-man crew required to handle it. Resistivity survey is often used due to its extra resolving power in that penetration depth control is obtained by varying the distance between electrodes.

Equipotential methods are carried out with resistivity generating equipment using dc galvanometers and potentiometers or ac galvanometers and vacuum tube voltmeters. The potential difference between two or more auxiliary electrodes is measured to determine deviations of the potential distribution due to the primary current flow. This is primarily a reconnaissance technique and has the advantage of ease of interpretation.

A circular line electrode method, developed by Lloyal A. Bacon for Calumet & Hecla Inc., is used to find the extension of a sulphide orebody from a single drillhole intersection. One electrode is dropped down the drillhole to the mineralized zone and a circular electrode of No. 10 bare copper wire is laid out around the drillhole at a radius of 700 ft. This circular electrode is fastened to the ground at 20-ft intervals with 4-in. copper staples. Equipotential surveys of the area with auxiliary electrodes produce circular equipotential contours whose anomalies show the main spread of the orebody. The method was confirmed by subsequent drilling.

Electro-Magnetic

An alternating current flowing in a loop of wire suspended above the surface of the earth sets up a primary magnetic field which causes electric to flow in buried conductors. These secondary induced currents in turn create a secondary magnetic field at the surface. Measurement in terms of "dip angles" of the resulting magnetic field makes it possible to detect buried conducting bodies—sulphides, magnetite, or graphite—and often to estimate the size, shape and depth of the body by comparison of the readings with scale-model data.

The technique has been successfully applied under almost any topographic conditions, including swamps and lakes, giving it an advantage over other electrical methods. Only highly conducting bodies are detected, thus electro-magnetic surveys do not map contacts or structure in the manner of resistivity surveys unless a good conductor happens to follow structural trends. Ground E-M surveys helped develop the Lynn Lake, Manitoba, nickel deposits and American Metals sulphide deposits in New Brunswick, using E-M together with other geophysical methods to map geological structure and to eliminate undesirable graphite bodies.

Ground E-M equipment uses an energizing coil from 4 to 20 ft high supplied with ac current at 800 to 1,000 cycles per second by a 1½-hp gasoline generator. Observations are made with 9-in. to 2-ft diameter receiver coils with the plane of the transmitting coil oriented towards the receiving coil to facilitate interpretation. Usually the transmitting coil is erected at a convenient central location and traverses made perpendicular to the assumed geological strike on either side of the transmitter. Traverses are up to 2,000 ft long along lines 400 ft apart for reconnaissance, closer for detailed surveys. Ground E-M equipment costs upwards of $2,000; contract E-M surveys about $2,000 per sq mile or $3,500 per month.

E-M equipment is now mounted in aircraft and E-M surveys can be run without difficulty at the same time as aeromagnetic surveys. The airborne instrument consists of a low frequency transmitter (400 cycles) in the aircraft and one or more receivers either in the aircraft (when the plane must be of wood construction) or in a bird at the end of a towline.

The latest airborne equipment permits E-M, magnetometer and scintillometer surveys to be carried out in one flight for a cost of $15 per line-mile (including the production of geophysical contour maps but excluding interpretation); this compares with $24 per line-mile for the three surveys carried out separately, (*E&MJ*, March 1956). This E-M equipment uses a dual frequency transmitter, 400 and 2,300 cps. The dual frequency reading assists subsequent interpretation since poorly conducting bodies give a greater response to higher frequencies. E-M and magnetometer surveys complement each other neatly as the magnetometer provides a regular picture of the geologic structure (besides detecting magnetic mineral concentrations) while E-M shows up important sulphide deposits.

Panorama of Earthmoving Equipment

FINGERTIP CONTROLS and operator comfort are stressed in newer designs of earthmoving equipment.

CURRENT REQUIREMENTS for high tonnage of low-grade ores have directed management's attention to newer and better ways of earthmoving which include the processes of digging, loading, scraping, hauling or transporting broken rock and overburden. Virtually every month new earthmoving units are brought to the attention of *E&MJ* readers in the New Products Digest.

The panorama of earthmoving machines, shown on the following pages, represents a selection of new units which have been introduced during the past year, and additional models obtained by canvassing all major equipment manufacturers. Despite the impressive number of designs shown, these units constitute only a part of the large number of machines available to mining. Purpose of the panorama is to give you perspective so that when earthmoving problems arise, you can scan the types shown and review the various methods by which the job can be accomplished.

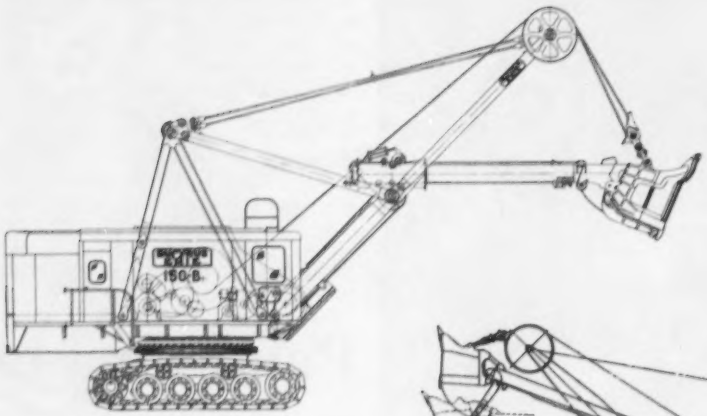
After you have evaluated such important factors as tonnage per day to be moved, length of haul, grade of haul, first cost of equipment, power availability and maintenance facilities properly, the unit or team of units to be selected will narrow down to a few choices.

At this point it will be helpful to refer to the classified directory of equipment and equipment manufacturers included in this issue. By writing to these companies you will receive a wealth of useful engineering data and information to help you select the best unit to perform your earthmoving job. Performance sheets, capacities, working ranges and design details are but a few of the important items that can be obtained by scanning manufacturer's literature.

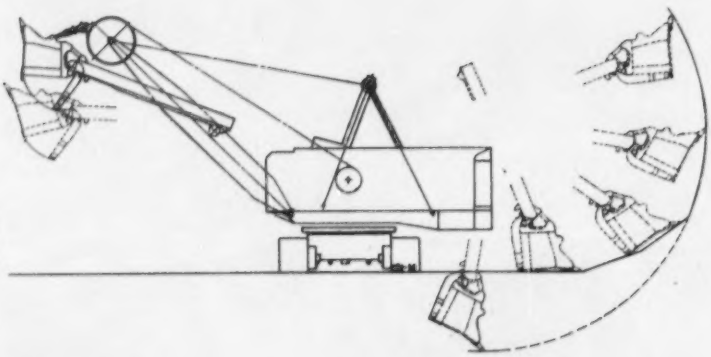
A few performance charts and tables are distributed throughout the earthmoving section to give you some idea of the engineering data available in typical modern equipment bulletins.

A study of new models reveals several important trends in design. Both manufacturers and mining companies are developing cabs such as the one shown above where operator comfort and fingertip controls, designed to respond to natural motions of the operator, increase the productivity of the machine.[1] In May 1956, *E&MJ* carried an article on the ventilated and air-conditioned cabs developed by Johns-Manville for open-pit operations at Lompoc, Calif. Engine manufacturers are delivering more efficient power packages for earthmoving machines. Electric units such as locomotives and power shovels are featuring greater safety for the operator through highly-protective grounding systems and relay systems which take high currents out of the operator's control equipment. Many machines designed for open-pit mining are now used underground, and an increasing number of underground models are adaptable to open-pit work.

[1] "Revolution in Controls." *E&MJ*, April 1954.

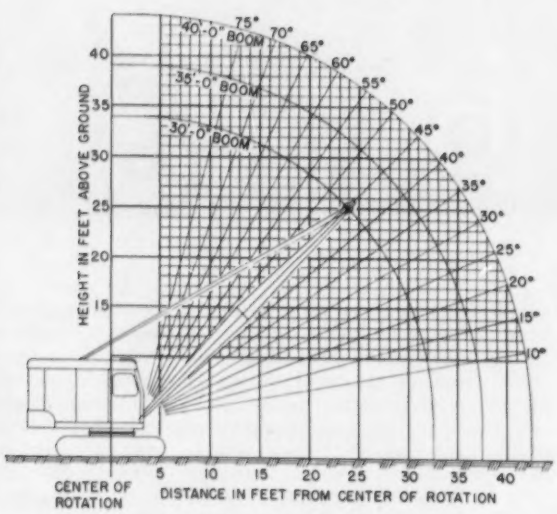


ELECTRICALLY DRIVEN 6-cu yd revolving shovel digs 9 to 10 ft below grade. Cutting height maximum is 37 ft. (Bucyrus-Erie, 150-B)

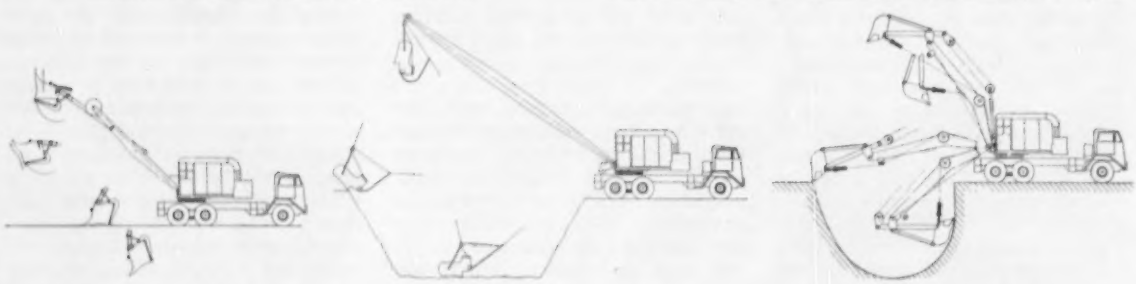


TEN-YARD electric power shovel is equipped with Ward-Leonard controls. Cutting height is 42 to 46 ft. Unit is powered by two 187.5-hp hoist motors, two 62.5-hp swing motors and one 62.5-hp crowd motor. (Marion, 191-M)

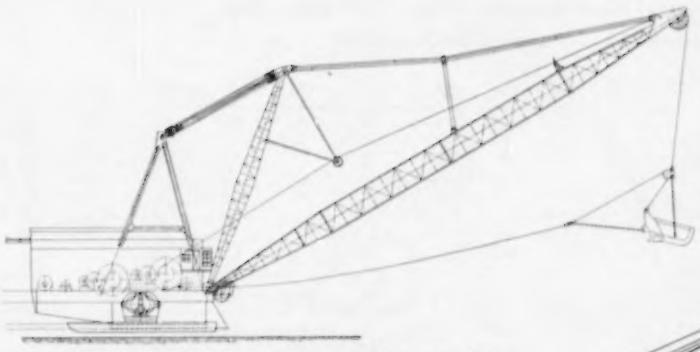
SCRAPERS, alone or in combination with other units, are effective. (Sauerman Power Drag, 2 cu yd)



HOW SHOVEL AND DRAGLINE PERFORMANCE varies with boom length and boom angle. (Northwest, ¾ cu yd)



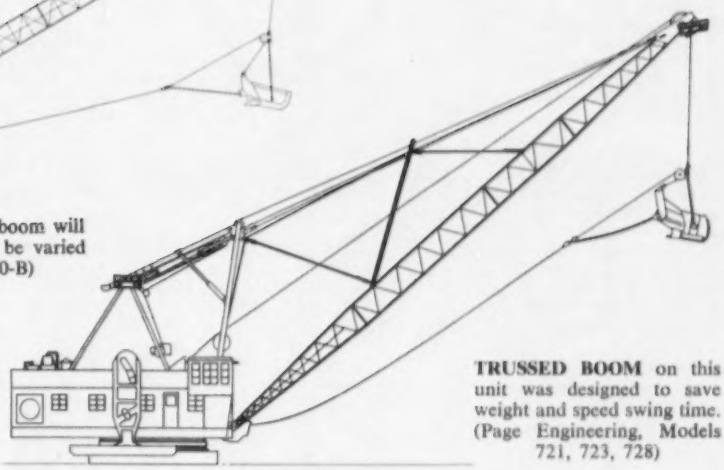
THREE EARTHMOVING applications of the rubber-tire mounted mobile power unit—shovel, dragline and hoe. Versatility is the outstanding advantage of this type of unit. (Thew-Lorain, MC-425)



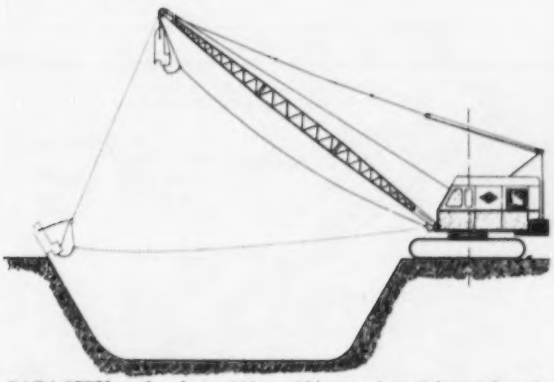
WALKING DRAGLINE with 200- to 235-ft boom will handle 23- to 30-yd buckets. Boom angle can be varied from 23 to 43½ deg. (Bucyrus-Erie, 1250-B)

Modern Models Designed for Mining

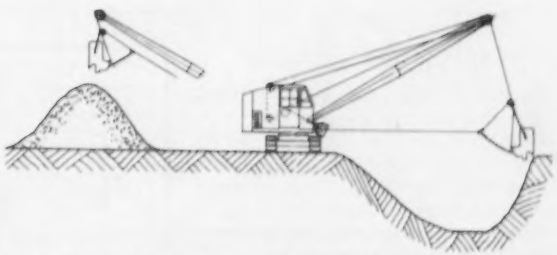
See next two pages for detailed performance data for all sizes and makes.



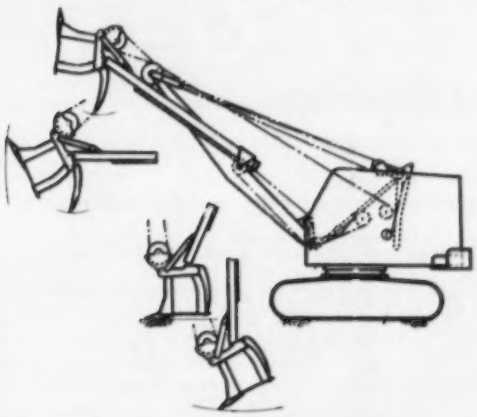
TRUSSED BOOM on this unit was designed to save weight and speed swing time. (Page Engineering, Models 721, 723, 728)



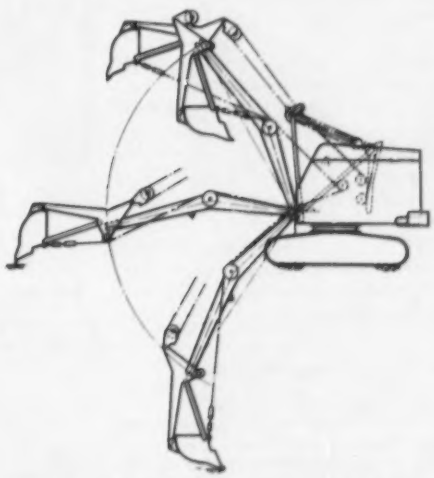
CAPACITY varies from 1¼ to 1¾ cu yd, and boom lengths from 50 to 70 ft. (Baldwin-Lima, 703 SC)



POWER for this 1½-cu yd unit is supplied by gasoline, diesel or electric motors. (Koehring 605)



GASOLINE OR DIESEL-POWERED tread-mounted power unit serves as shovel or hoe. Shovel capacity is ¾ cu yd.



Bucket for hoe holds 0.55 cu yd. Boom length is 16 ft. Boom angle varies from 40 to 60 deg. (Link-Belt Speeder, LS-68)

Useful Capacity and Performance Data for Draglines

(All dimensions in feet unless otherwise specified)

Bucket size, cu yd	½	⅝	¾	1	1½	1½	1¾	1¾	2	2½	2¾	3
J. Boom length	35	40	60	50	60	50	50	80	60	50	110	60
K. Boom angle, deg	40	40	40	40	40	52	40	41	40	40	32	50
A. Dumping radius	32	35	50	43	50	35	46	65	53	46	100	45
B. Dumping height	17	20	22	24	30	36	23	47	29	23	49	35
C. Digging depth	15	18	27	21	27	18	24	42	24	24	58	17
D-A. Bucket throw	6–9	8–10	8	8–10	10–12	12–18	7–11	15–20	10–15	7–11	20–30	5–15
I. Bucket dimension	10	10	12	13	13	13	13	14	14	14	16	16
Source of data*	TL	TL	BLH	BLH	BLH	K	TL	LB	TL	TL	—	M

Bucket size, cu yd	3	3½	3½	3¾	4	4	4½	4½	5	6	7	8
J. Boom length	110	110	100	100	100	90	90	80	100	90	80	80
K. Boom angle, deg	37	41	34	39	43	36	41	38	37	39	41	41
A. Dumping radius	95	90	90	85	80	80	75	70	90	80	70	70
B. Dumping height	56	62	45	51	56	41	47	38	42	39	34	35
C. Digging depth	51	45	61	55	50	39	33	43	41	34	28	28
D-A. Bucket throw	20–30	20–30	15–25	15–25	15–25	15–25	15–25	10–20	15–25	15–25	10–20	10–20
I. Bucket dimension	16	16	16	17	18	18	18	18	20	20	21	21
Source of data*	LS	—	—	—	—	—	—	—	—	—	—	—

Bucket size, cu yd	10	12	13	20	23	25	26	30	30	30	35
J. Boom length	200	185	175	280	235	260	235	240	235	200	220
K. Boom angle, deg	31	32	33	35	30	35	36	35	43½	30	35
A. Dumping radius	190	175	165	250	222	234	209	218	190	191	201
B. Dumping height	81	73	70	138	98	124	116	110	136	76	98
C. Digging depth	97	87	80	120	140	111	145	102	120	120	94
D-A. Bucket throw	30–50	30–45	30–45	50–70	—	45–65	—	40–60	—	—	35–55
I. Bucket dimension	26	29	29	28	—	31	—	34	—	—	35
Source of data*	—	—	—	—	BE	—	BE	—	BE	BE	—

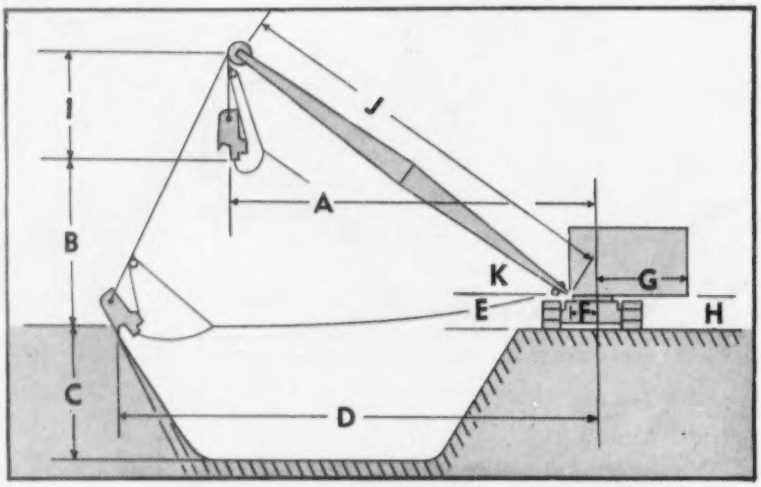
Explanation of tables

***Source of data.** This is a revision of a table published in *E&MJ*, May 1954, which was based in part on data obtained from the Power Crane and Shovel Association, supplemented by data from manufacturers' bulletins. Smaller size dragline data above was contributed by the following: BLH, Baldwin-Lima-Hamilton; K, Koehring; LS, Link-Belt Speeder; M, Marion; TL, Thew-Lorain. Larger sizes from 3 cu yd and up were checked against Marion Power Shovel Co. specifications.

Note: The above data is presented to show what representative types of draglines can do. However, data for specific models vary considerably with boom angle and length of boom. For specific earthmoving problems, the reader is advised to refer to the manufacturers listed under draglines and power shovels in the Buyers' Guide of this issue. Bulletins available will give much useful engineering information required to select the best equipment for a particular job.

For Your Convenience

A Buyers' Guide and Directory of Manufacturers is included in this issue to enable you to contact companies which make supplies and products, or offer services to the mining industry. Several convenient return postcards are available which will assist you in contacting companies which carry advertising messages in this issue.



Refer to this drawing for symbols shown in dragline table above.

Weights of Materials (One cu yd—weight in pounds)

Material	Weight	Material	Weight
Clay, dry in lumps	1,701	Gravel, wet, packed	3,240
Clay, compact	2,943	Iron ore, 60% iron	8,100
Coal, anthracite	1,512	Iron ore, 50% iron	6,750
Concrete, ready to pour	3,996	Iron ore, 40% iron	5,400
Dolomite, crushed fine	2,565	Limestone, run of crusher	2,565
Earth, loamy, dry	2,025	Limestone, fines out	2,700
Earth, dry, packed	2,565	Limestone, above 2 in.	2,160
Earth, set (mud)	2,970	Phosphate rock	2,160
Gypsum, crushed	2,565	Sand, dry, loose	2,565
Gypsum, calcined	1,620	Sand, wet, packed	3,240
Gravel, dry, loose	2,970	Shale, broken	2,295
Gravel, dry, packed	3,051	Sulphur, broken	1,620

Useful Capacity and Performance Data for Power Shovels

(All dimensions in feet unless otherwise specified)

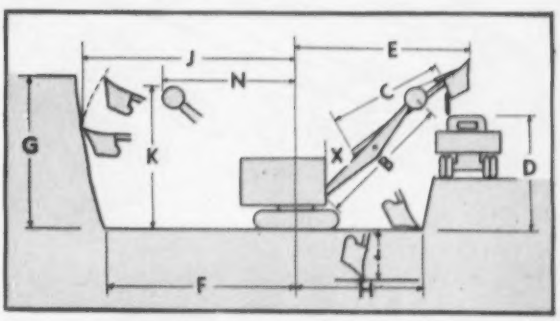
Dipper capacity, cu yd	½	½	¾	¾	¾	1	1	1½	1½	1¾	2½
Special type*	—	—	—	—	—	—	—	—	HD	—	HD
X. Boom angle, deg	45	50	60	50	45	50	45	50	60	50	50
B. Boom length	17	16	18	16	17	18	21	23	22	23	26
C. Dipper handle length	15	12	15	12	15	14	18	18	17	18	20
D. Dumping height, max	14	16	17	15	13	18	19	21	24	19	24
E. Cutting radius, max height	21	18	19	19	20	21	24	26	21	26	29
G. Cutting height, max	21	22	27	22	22	26	26	30	33	29	34
J. Cutting radius, max	25	24	24	24	25	28	30	32	30	32	37
I. Cutting depth below grade	7	5	5	6	7	7	8	7	6	7	8
H. Radius of cleanup	17	14	16	15	16	20	20	21	19	22	23
Maker**	TL	LS	NW	LS	TL	LS	NW	LS	K	TL	K
Model No.	15	58	25	68	25	98	41	K360	605	72	1005

Dipper capacity, cu yd	2½	2½	3	3	3	3½	4	4	4½	5–6
Special type*	HL	—	—	—	—	—	—	HL	—	—
X. Boom angle, deg	50	45	50	45	60	50	45	50	45	45
B. Boom length	42	25	28	29	27	29	33	67	32	35
C. Dipper handle length	32	18	20	20	19	19	22	50	21	23
D. Dumping height, max	38	18	21	20	28	23	24	60	21	22
E. Cutting radius, max height	50	30	32	34	38	33	37	70	39	44
G. Cutting height, max	49	28	32	30	40	34	35	73	32	34
J. Cutting radius, max	55	36	37	38	38	38	44	82	44	47
I. Cutting depth below grade	14	9	9	8	8	8	10	4	8	8
H. Radius of cleanup	31	23	24	23	26	24	29	50	27	28
Maker**	BL	BL	—	M	LS	PH	BL	BL	PH	PH
Model No.	1201	803	—	101M	K608	1055E	1601	2400	1400	1500

Dipper capacity, cu yd	6	6	6	7	7	7	8	8	9	10	10
Special type*	—	—	—	—	—	LR	—	—	IR	—	—
X. Boom angle, deg	50	45	45	50	45	45	45	45	45	50	45
B. Boom length	38	35	38	38	37	70	39	43	55	40	44
C. Dipper handle length	23	23	23	23	23	40	23	25	32	25	27
D. Dumping height, max	23	24	24	25	25	52	27	26	39	31	27
E. Cutting radius, max height	45	45	46	44	48	74	48	49	60	48	52
G. Cutting height, max	35	37	37	37	38	65	41	40	54	46	42
J. Cutting radius, max	47	49	49	48	51	79	53	54	67	56	57
I. Cutting depth below grade	9	8	10	9	9	8	8	11	5	12	13
H. Radius of cleanup	30	30	33	30	32	45	35	35	43	37	38
Maker**	—	PH	BE	M	—	PH	PH	M	PH	—	M
Model No.	—	1600	150B	151M	—	1855	1800	181M	1855	—	191M

Table continued (Larger Sizes)

Dipper capacity, cu yd	18	40	45	45
Special type*	—	SS	—	SS
X. Boom angle, deg	45	45	49	45
B. Boom length	105	113	120	113
C. Dipper handle length	69	70	79	64
D. Dumping height, max	73	76	80	71
E. Cutting radius, max height	112	107	120	106
G. Cutting height, max	92	104	107	100
J. Cutting radius, max	120	132	131	127
I. Cutting depth below grade	—	—	—	—
H. Radius of cleanup	69	76	71	76
Maker**	—	BE	—	BE
Model No.	—	1050B	—	1050B



Refer to this drawing for symbols in shovel table above.

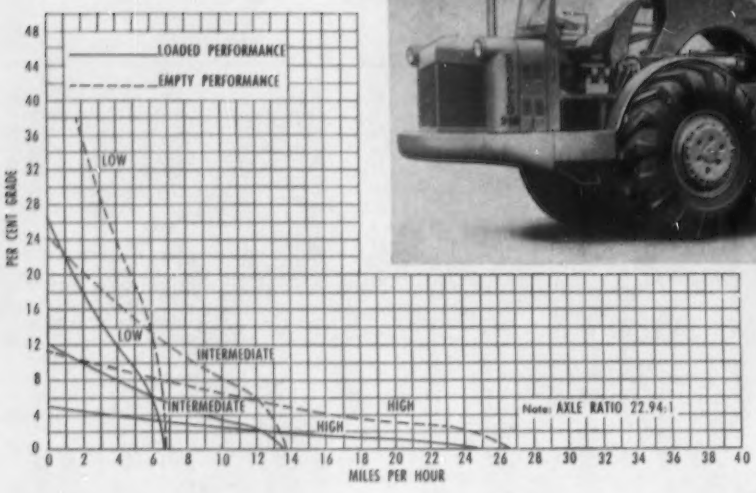
Explanation of Tables

Note: For details pertaining to a specific earth-moving problem, consult the manufacturers listed under Power Shovels in the Buyers' Guide section of this issue. Bulletins supplied by shovel manufacturers present complete data including performance ranges for boom angles varying from 40 to 60 deg. These bulletins also show mechanical details of the units and specify power source including diesel engines, diesel-electric units, gasoline engines and electric motors equipped with Ward-Leonard or rotating controls.

***Key to symbols**—HD, Heavy Duty; HL, High Lift; IR, Intermediate Range; LR, Long Range; SS, Stripping Shovel.

****Key to symbols**—BL, Baldwin-Lima-Hamilton; K, Koehring; LS, Link-Belt Speeder; M, Marion; NW, Northwest; PH, Harnischfeger; TL, Thew-Lorain; BE, Bucyrus Erie.

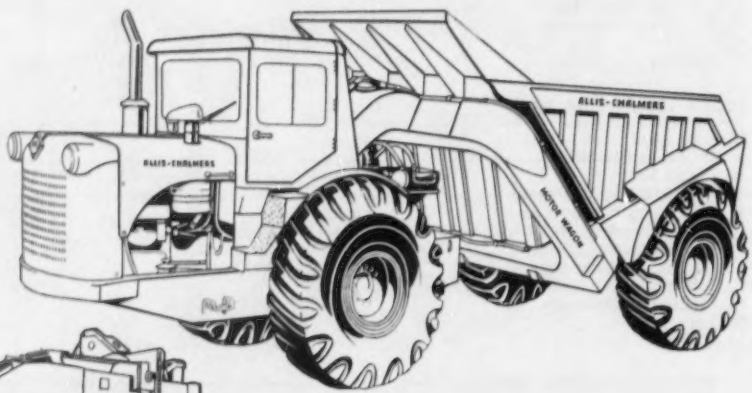
Note: The above data is presented to show what representative types of shovels can do. It is based in part on a table prepared by the Power Crane and Shovel Association, and supplemented with manufacturer's data supplied for this issue.

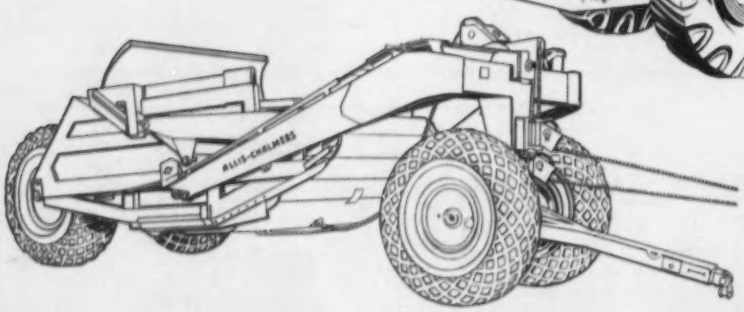

LOADED PERFORMANCE
EMPTY PERFORMANCE
LOW
LOW
INTERMEDIATE
INTERMEDIATE
HIGH
HIGH
Note: AXLE RATIO 22.94:1
PER CENT GRADE
MILES PER HOUR
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40
0 4 8 12 16 20 24 28 32 36 40 44 48

DIESEL-POWERED 18-cu yd scraper is equipped with torque converter. Load is ejected by roll-out action with snap at end of stroke. (Euclid, S-18)

CHART AT LEFT shows speed performance for various grades for the Euclid S-18 model.

REAR-DUMP ROCK WAGON, right, has 11-cu yd struck capacity, 15-cu yd heaped. Five forward speeds go up to 21.6 mph; reverse to 2.5 mph. (Allis-Chalmers, TR-200)

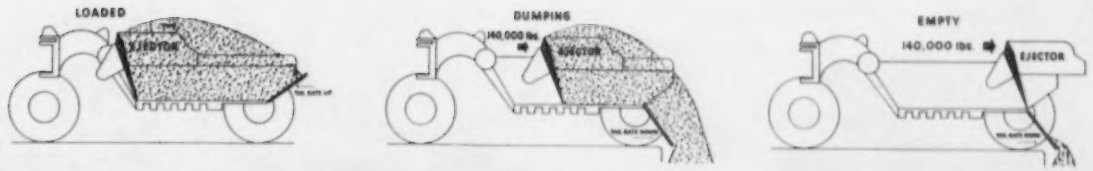




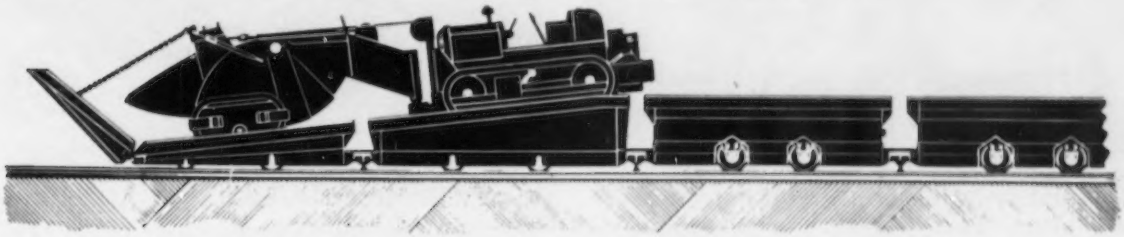
PULL-TYPE SCRAPER capacities range from 4 to 15 cu yd struck. Hydraulic and cable controls insure positive cutting, loading and forced ejection. (Allis-Chalmers, 315)

BOTTOM-DUMP MOTOR UNIT has 17-cu yd struck capacity, and 20- to 25½-cu yd heaped. Air valve controls doors. (Euclid, 22TDT)

FAST-ACTION rear-end dump designed for maneuverability. (Le Tourneau-Westinghouse)

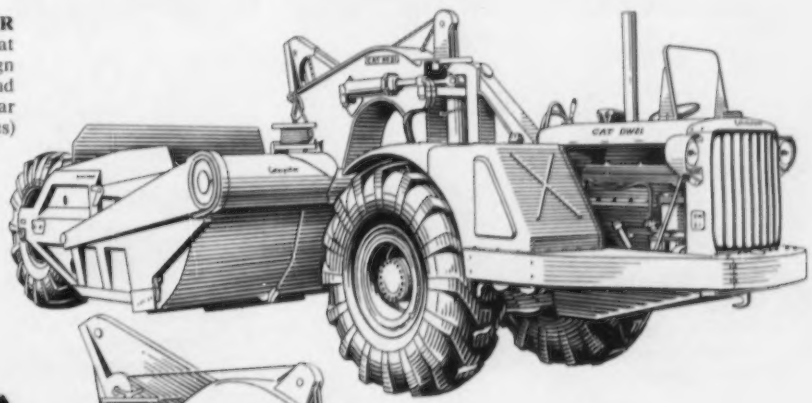


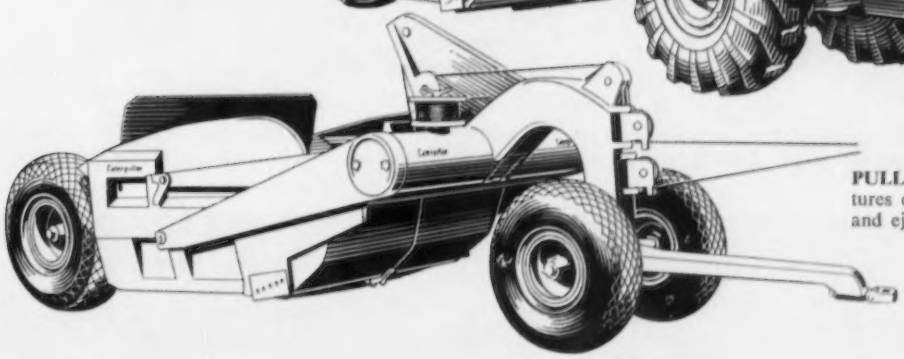
CONTROLLED EJECTION is the chief advantage of this unit. To dump, the operator releases a backhaul drum to drop tailgate, and engages the ejector drum which exerts a 140,000-lb push on load. (C & D, Movall)



LOADER COMBINATION picks up load and mounts ramp to fill cars. (Sanford-Day, Gismo)

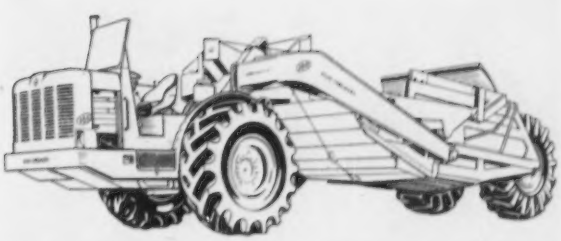
NEW DIESEL TRACTOR (right) is rated at 300 hp at 1,800 rpm. "Lowbowl" design of scraper increases ease and economy of loading. (Caterpillar DW21 series)





PULL-TYPE SCRAPER features cable control for loading and ejection. (Caterpillar)

WHEELED SCRAPER has heaped capacity of 41 cu yd. Cable controls use power of tractor. (Wooldridge, Terra-Clipper)

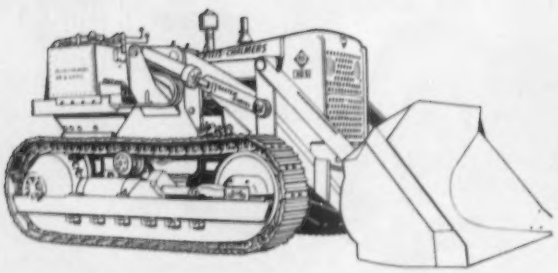


MOTOR SCRAPER has 15-cu yd struck capacity. Is equipped with cable controls. (Allis-Chalmers, TS-360)

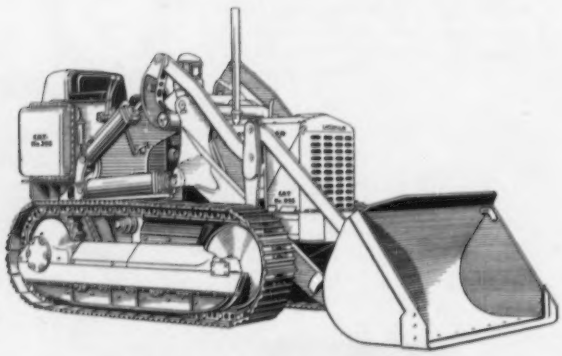
NEW MODEL developed to replace old cable-operated type, and speed loading. (Ulrich Products, DH-4 Model)

PNEUMATIC-TIRE MODEL combines speedy positioning and loading. (Hough Loader on International Harvester unit)

Loaders Designed for Speed, Rough Terrain and Versatility



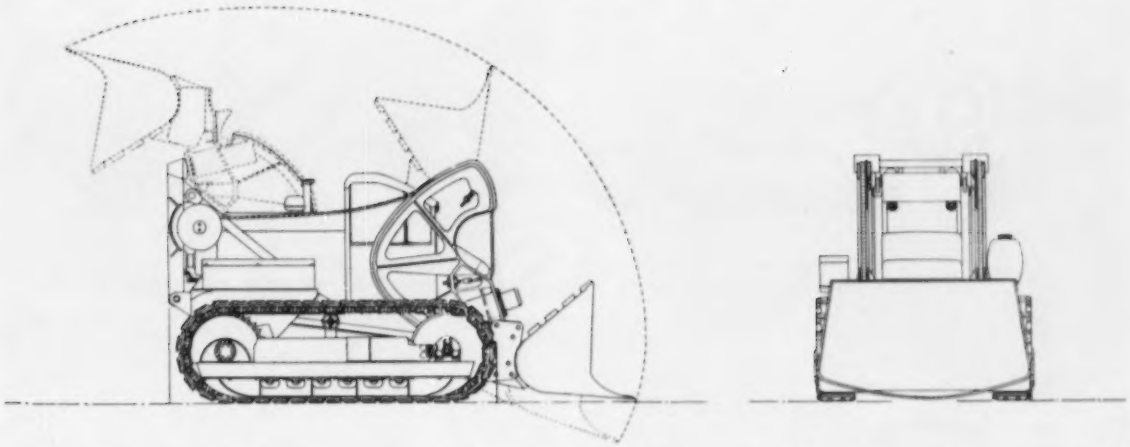
TRACTOR SHOVEL capacities range from 1½ cu yd to 4 cu yd. Larger sizes have torque converters. (Allis-Chalmers)



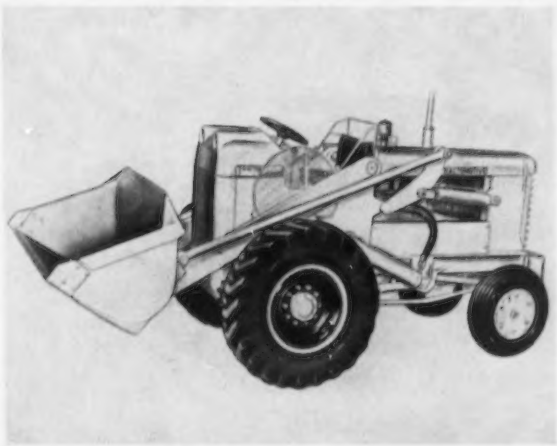
CRAWLER-MOUNTED front-end loader designed for heavy duty performance. (Caterpillar Tractor, Model No. 955)

TIRE MOUNTED unit carries 2¼-cu yd bucket. Is powered by gasoline or diesel engine. (Clark Equipment, Model 175-A)

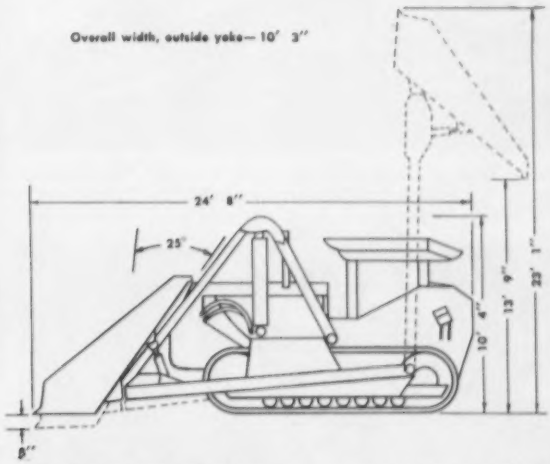
TRACTOR-LOADER is equipped with 2¼-cu yd bucket. Long tracks give extra stability. (Caterpillar, Traxcavator No. 977)



TRACTOR-EXCAVATOR of the over-cast type carries operator in protected cab. Four-cycle diesel engine develops 125 hp at sea level. Power is transmitted through a torque converter to cushion loading shocks. (Eimco, Model 105)



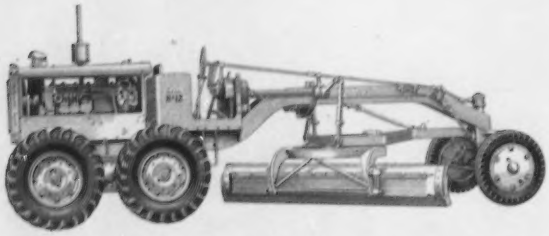
TRACTOR-LOADER carries 1⅛-cu yd bucket. Drive is front-wheel type. Steering is rear-wheel. (Tractomotive Corp. TL-11)



OVERSHOT LOADER operates on powerful hydraulic principle. Capacity range, 1 to 4 cu yd. (Austin, Model 8-C)

TRUCK-MOUNTED loading bucket rotates through 120 deg. Loader is hydraulic type. (Holmes-Owen, Truck Loader)

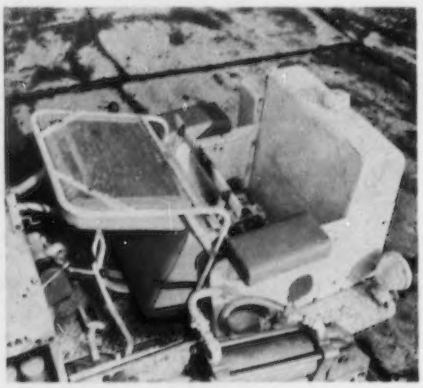
WHEEL-TRACTOR LOADER bucket capacity ranges from 9 cu ft to ¾ cu yd. (Ford Motor Tractor Div., Industrial Loader)



ROAD GRADERS such as this diesel-powered model slash open-pit tire repair costs. (Caterpillar, No. 12)

EQUALLY IMPORTANT for road maintenance and low tire repair bills in pits is this patrol sweeper. (Allis-Chalmers)

NEW CRAWLER tractor develops 66 engine horsepower. Clutch facings are of heat-resisting cerametallic material. Raised foam-rubber seats provide operating comfort. (International-Harvester TD-9)



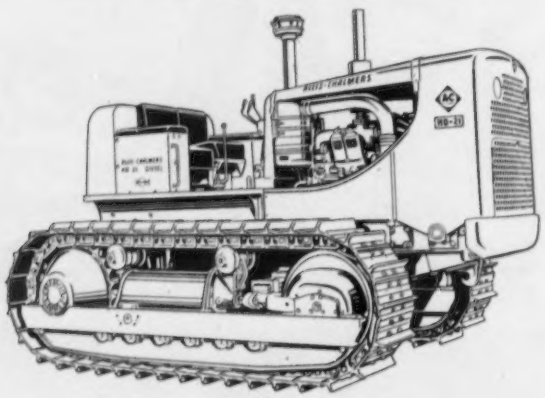
NEW TIP-OVER SEAT permits quick and easy servicing of steering clutch assemblies. (International Harvester TD-6 and TD-9)

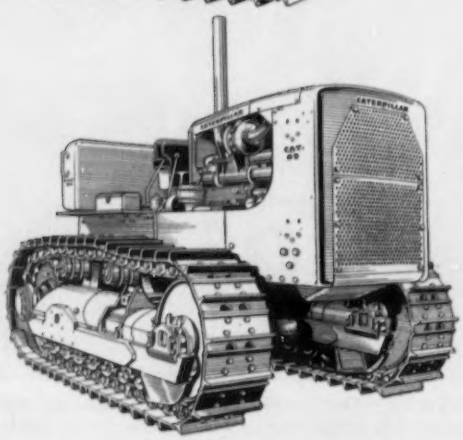
New Tractors

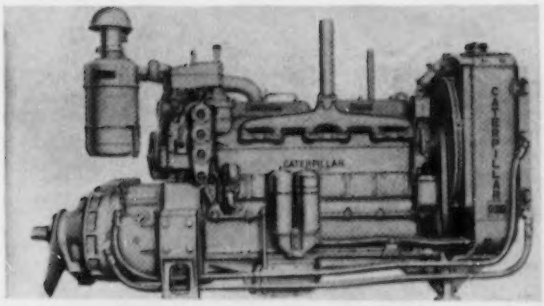
THE TWIN-ENGINE CRAWLER shown above left is equipped with separate Torqmatic drives which deliver 388 hp. This tractor has three speed ranges forward and backward up to 8.3 mph. Halves of the tractor are connected only by one large transverse shaft permitting independent motion of the tracks on rough ground. (Euclid, TC-12)

The heavy-duty crawler tractor, above right, weighs 44,000 lb, develops 204 net engine horsepower, and is equipped with hydraulic torque converter drive. (Allis-Chalmers, HD-21)

The tractor at right is powered by a 4-cycle engine with turbocharger. It is available in direct drive or torque converter speeds up to 7.8 mph. (Caterpillar, D-9)



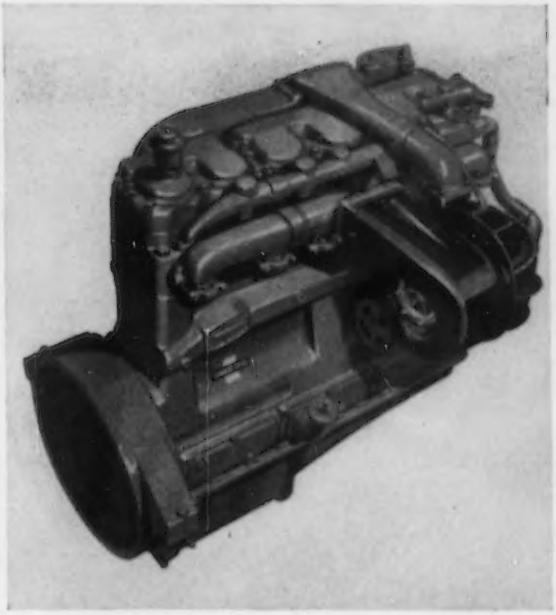




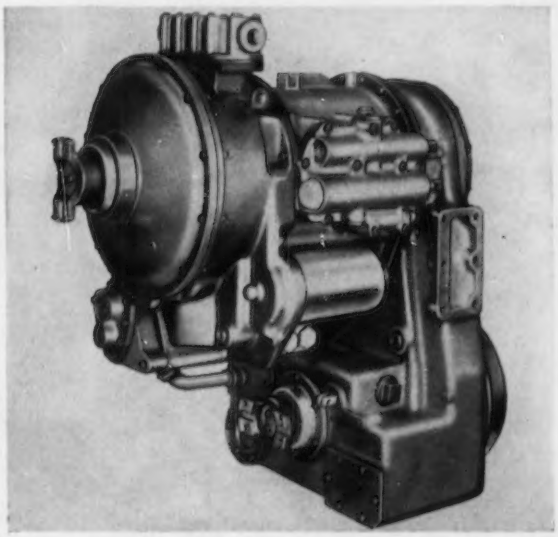
A WIDE CHOICE of torque converters is offered with this model to save wear on equipment. (Caterpillar, D318)

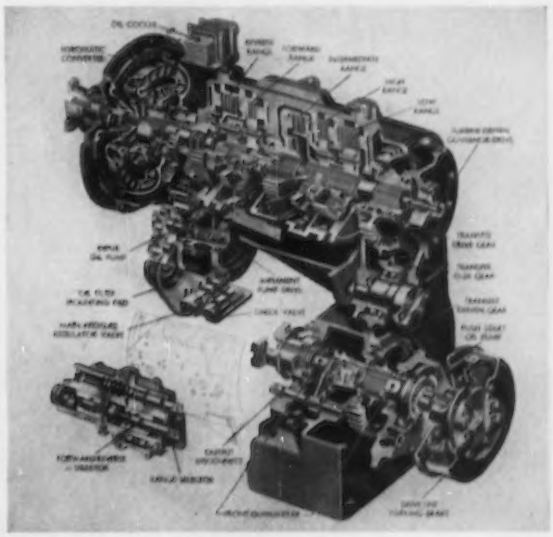
Power Packages and Transmission

MANY EARTHMOVING MACHINES are purchased as basic units, but the mining man has a choice of the numerous components that make up the machine. Among these are included: the engine or power package; transmission equipment which may involve torque converters and special clutches; the car or truck body; hydraulic or other devices to dump or discharge the load; bearing installations; and truck bogeys and rail car running gear. Special emphasis has been placed on power packages and transmission units by manufacturers. Consult the buying directory for complete sources of information on components.



TURBOCHARGER harnesses exhaust gas energy normally wasted on diesels. This is one of five new models ranging from 175 hp to 600 hp. (Cummins 300-hp, NRT-6)





What Goes Into a Power Transmission Device

THE ABOVE ILLUSTRATIONS reveal the inside and outside structure of a modern torque-converter designed to be used with gasoline or diesel engines in the 70- to 130-hp class. It has three speeds forward, and three in reverse, with a wide range of application in loaders, graders, and trucks. Advantage of this kind of transmission is that it speeds the job cycle, and thereby makes the machine more valuable to the mining man because it increases the output of labor and equipment alike. Available with this transmission are a wide variety of options and accessories including two converter capacities, two implement pump drive ratios, filter, two transfer gear ratios, disconnect for one output shaft, oil cooler and engine or remote mounting. This "Torqmatic" transmission permits the engine to operate at maximum efficiency, prevents harmful engine lugging, eliminates shock loads, reduces operator training time and provides more effective horsepower. (Allison Div., General Motors. Torqmatic, CRT-3330)

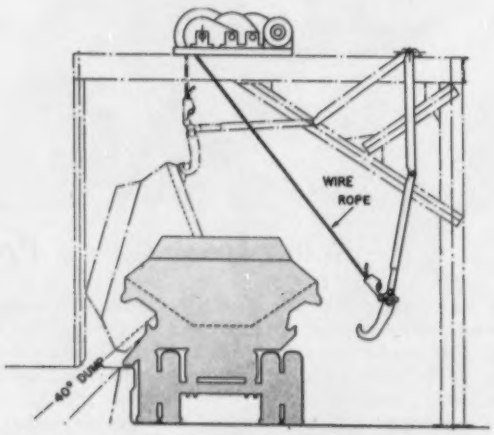
TRUCK-TRACTOR with semi-trailer has a struck capacity of 32 cu yd, and gross combined weight of 165,000 lb. Powered by 300-hp Cummins diesel. (Kenworth, 802-b)

FIFTY-TON truck is powered with two 300-hp Cummins diesels, and two Allison torque converters. Speed range in high is 32 mph. (Euclid, Model 1LLD)

THIRTY-FIVE-TON hauler is equipped with 335-hp Cummins diesel, Twin Disc converter, Fuller transmission, Timken front axle, Dart rear axle. (Dart, 35-T)

FAST-DUMPING earth-hauler is used here with intermediate power shovel for highly selective open-pit mining in New Mexico uranium operations. (Koehring Dumptor)

HIGH-SPEED off-highway truck carries 18-ton load. Comes with 5- or 10-speed transmission. Will travel up to 36.5 mph (International, Payloader 65)



AUTOMATIC ELECTRIC DUMPER consists of overhead electric hoist with pushbutton station, and counterweight on A-frame holding dumping hook. (Easton Model HE-20)

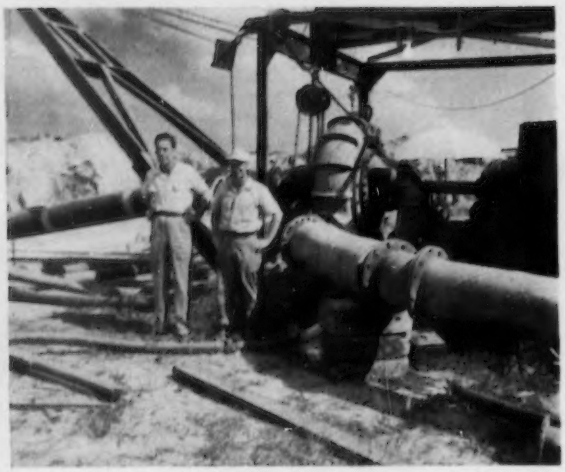
TELERAMIC FRAMELESS dump trailer is lifted with single hydraulic cylinder on tractor fifth wheel coupling. (Anthony Co.)

TRAILER DUMP with dual piston hoist holds 10 to 20 cu yd. It is designed for towing behind truck where laws require wide axle spacing. (Galion All-Steel Body Co.)

TWIN TRAILERS are equipped with twin pistons. Units dump to either side. (Easton trailers)

NEW RUGGED TRUCK LINE is powered by 170- to 300-hp engines including a new turbocharged engine. Power steering and new exhaust brake are other features. (Mack B-80 line)

MOTOR WAGON powered by 280-hp diesel engine carries a 17-cu yd struck load. Four forward speeds go up to 20 mph; reverse, to 3.1 mph. (Allis-Chalmers TW-360)



DRAGLINES AND PUMPS. A common team in the Florida phosphate field is the dragline (above) with 17- to 26-cu yd bucket feeding pumps which deliver phosphate ore over pipelines as long as 13 miles. Pumps made by various manufacturers are built to a standard specified design. Pipes are Spiralweld and seamless.

DRAGLINES AND BELT CONVEYORS were used to transport large tonnages of gold-bearing gravel at this mine.

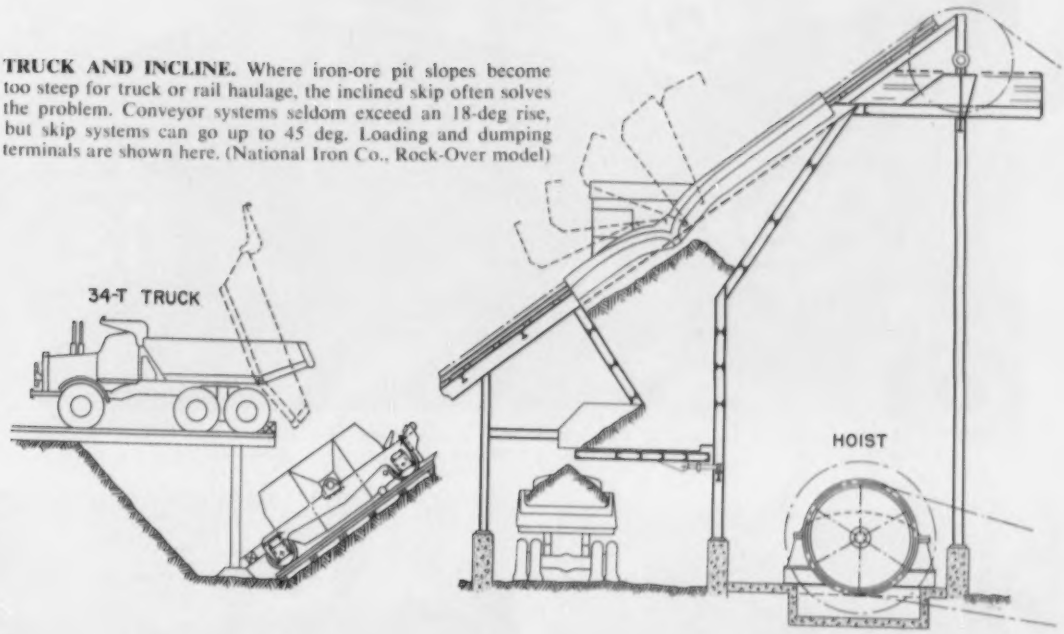
TRUCKS AND CONVEYORS are common on Minnesota Iron Range pits where pits become too steep for rails.

How Combinations Solve Pit Problems

PIT PLANNERS are paying more attention to combinations of conventional equipment with a view to overcoming steep grades, rolling terrain in transport areas, high cost of transport and other problems. In one Canadian pit the operators found that hydraulicking and transport by pump and pipeline was much cheaper than truck and shovel. In Reynolds' Jamaica bauxite operations, the ore moves from shovel to bottom-dump trailer, to belt conveyor, to stockpile serviced by overhead crane, to belt, to aerial tramway and finally by belt to ship. Other combinations include: dragline to conveyor, dragline to pump; truck to conveyor; truck to inclined skip; dragline to dredge; and hydraulic giant to dredge. These combinations do not exhaust the list. They are set down to stimulate interest and imagination in selecting combinations of conventional earthmoving units that will do the job best.

CONVEYOR-TO-TRAMLINE haulage solved the problem of transporting bauxite at Reynolds' Jamaica mine.

TRUCK AND INCLINE. Where iron-ore pit slopes become too steep for truck or rail haulage, the inclined skip often solves the problem. Conveyor systems seldom exceed an 18-deg rise, but skip systems can go up to 45 deg. Loading and dumping terminals are shown here. (National Iron Co., Rock-Over model)



BULLDOZERS, DRAGLINES, MONITORS AND DREDGES work together as teammates in Alaskan placer goldfields, where thawing equipment often has to be introduced to make the ground workable. Hydraulic giants perform the tasks of thawing, cutting and transporting. In some open pits, transport costs have been cut from dollars to cents per yard with hydraulic giants and pumps. The unit at right requires no operator. (Chiksan Co., Intelli-Giant model)

Giant Bucket-Wheel Digger ►

THE WORLD'S LARGEST bucket-wheel excavator used in brown coal open-pit mines in Cologne, Germany, carries a 52½-ft diameter bucket wheel fitted with twelve 4½-cu yd buckets. The machine can dig up to 2.6 cu yd per sec. The digger moves on 18 crawlers and can travel at speeds up to 33 fpm. This machine was built cooperatively by Orenstein-Koppel und Luebecker Maschinenbau, AG, in Luebeck. Krupp is also building a similar bucket-wheel digger.

HOPPER-BOTTOM 50-ton car at Cerro de Pasco is constructed with cast-steel side frame and Timken bearings. (Gregg Car Co.)

ROTARY DUMPER installed to handle large tonnages of iron ore at Venezuelan operations. (Wellman unit)

ROTARY DUMPER at terminal of Kaiser Bauxite Co. operations at Port Kaiser, Jamaica.

Railroading

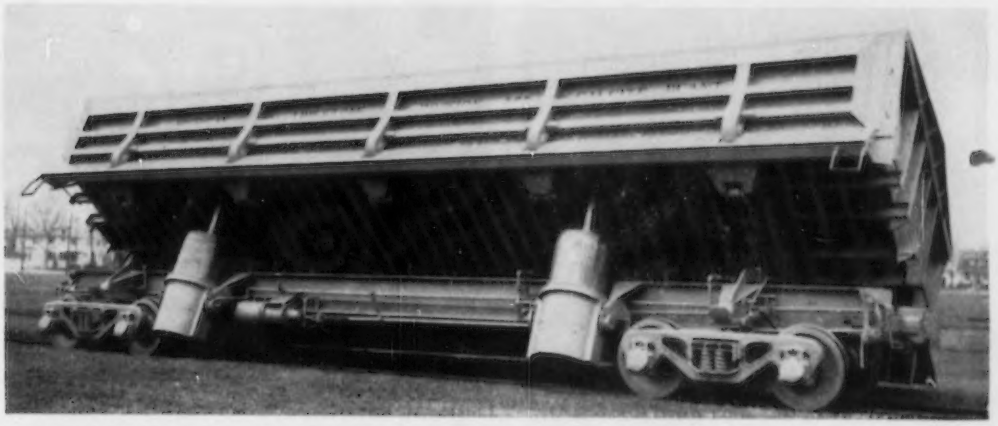
Next to railroading itself, mining is the largest railroading industry in the world!

TIPPLE CAR is equipped with roller bearings, air brakes and coil springs. (Gregg Car Co.)

TREMENDOUS TONNAGES of ore and waste are transported each day by the underground and open-pit mines of the world—ranging from 50,000 to 100,000 tons or more for the large open-pit mines, and from 10,000 to 40,000 tons or more for underground operations. When the earth-moving materials-handling requirements of an operation reach these proportions, railroading provides the best answer. Electric trolley haulage predominates in the larger mines, and diesel-electric combinations handle a large share of open-pit tonnages. Only when the distance of transport is relatively short, or when the grades are excessive, do other modes of transport invade the large-tonnage field.

Seldom is it realized that mine railroads are now handling tonnages that approach or even exceed those handled by some of the large commercial lines. For instance, San Manuel's company-owned railroad will handle about 35,000 tons of ore per day underground, and on the surface to the mill. This is about half the tonnage handled daily on the main line of the Southern Pacific Railroad. Tonnages which will ultimately go over the company-owned railroad lines of the taconite producers may well exceed those handled by any commercial line.

See also section on underground railroading, p 76.



TWO-WAY SIDE-DUMP car is operated by two pairs of powerful air pistons. No locking device is required. (Differential Steel Car unit)

CAR SHAKER used to speed unloading of coal and other materials at large Canadian metallurgical plant.

POWERFUL HYDRAULIC system is used to unload side-dump cars at Anaconda's Chilean operations.

What to Consider When Selecting Mine Cars

FRANK PICKARD

THESE SUGGESTIONS APPLY to underground as well as surface ore cars. Self cleaning is a feature which all mines want, but which is difficult to achieve with certain ores. Ores tend to pack wherever there is a sharp angle. Thus it is advisable to curve the juncture or enlarge the angle of contact between sides and bottom.

Mine cars may be fabricated in several ways. Simplest is to rivet standard shapes together. If the ore is highly abrasive, wear plates may be added. Welding saves weight in car construction. Hot die pressing allows plates to provide their own stiffening, thus eliminating some of the extra shapes used for this purpose.

Mr. Pickard was formerly vice president of Gregg Car Co., manufacturers of mine cars and equipment.

High-tensile alloy steels increase first cost of cars, but make up this investment in lower maintenance. Stainless steel, aluminum and rubber may be used for liners for special cases.

Repeated blows due to impact loading often weaken car bodies. The commonest prevention is the wood sandwich floor. Synthetic rubbers can also be used. Thickness required for rubber is about ½ to 1/3 that for the wooden sandwich. Cost is slightly higher.

Six Standard Types

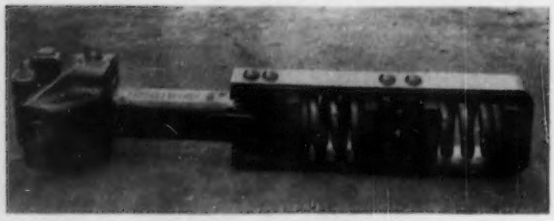
Small mine car bodies are usually one of six standard types; tipple, V-dump, gable, rotary, end-dump or Granby-type.

The tipple body is the simplest. (See illustration.) It is lightest and cheapest per cubic foot of capacity, and normally has the lowest maintenance cost. Its major disadvantage is that it can only be used for main-line haulage and development work.

V-bottom cars are simple in design and strong. The rocker design is the important feature of these cars. The V-dump car is the most versatile for main-line haulage and development work.

The Granby type is designed for automatic dumping, but the mechanisms required contribute to high maintenance costs.

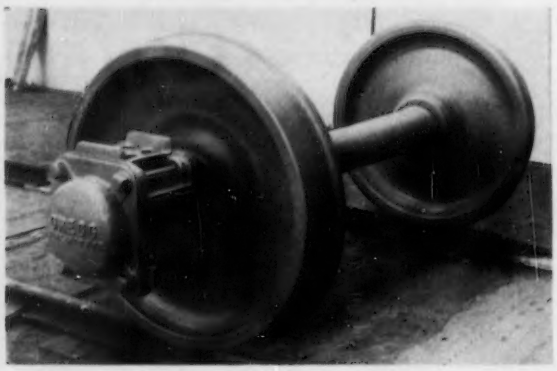
Gable cars are useful for main-line haulage and development. But they cannot be readily discharged except at at a double grizzly. The gable construction is strong, but the doors and locks



SIMPLE-TYPE draft gear, above, may be all steel or a combination of rubber and steel to absorb shock.

← **DRAFT GEAR,** left, is built into the link and pin coupler and attached to the underframe of the car as a unit.

CAST-STEEL WHEEL with roller bearing inside turned axle, is designed for small cars. Mountings are cast-steel.



SINGLE-WEAR rolled steel wheels are cheaper than multiple-wear wheeels. Will last 15 to 30 years for moderate use.

Components to Consider When Selecting a Mine Car

may introduce maintenance problems.

Small rotating dump cars are versatile for underground operations because they can be dumped to either side of the track. Most of the maintenance problems are confined to the pivoting device and the door-locking mechanism.

End-dump cars are strong and can stand abuse. They are not as versatile as other models because they must be uncoupled and dumped individually. Chief maintenance problem is the bottom hinge and the door-closing device.

Car Parts

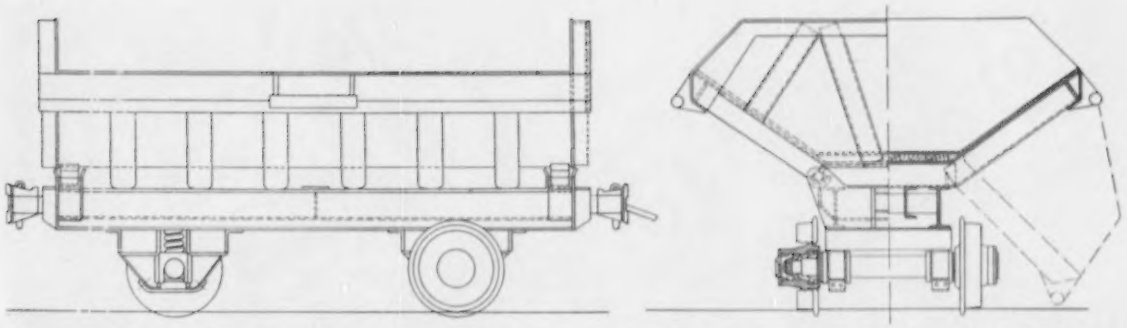
Couplers and draft gear. Two types of couplers are available—automatic and non-automatic. For small cars a simple link and pin may be satisfactory, but for cars exceeding 40-cu ft capacity, a heavier coupling is required. If cars have to be coupled and uncoupled constantly, automatic couplers are recommended. Where ore is wet and loaded with fines, the top operating coupler should not be used. Even the bottom-operating type will jam when it becomes full of fines. Where cars exceed 25 to 30 tons, it may be necessary to use the railway standard of the country since it may be necessary to move cars over main railway lines.

Cars with capacity above 40 cu ft, or 2 tons, should be fitted with some sort of **shock absorbing coupling** system, called draft gear. The coupler is attached to a yoke or tail bolt by a draft key or pin. The draft gear can be built into the link and pin coupler and attached to the underframe as one unit. (See illustration.) If automatic couplers are needed or if the load exceeds 10 tons, a regular draft gear must be incorporated in the underframe.

Draft gears come in two types—the spring type, and the friction type. Spring draft gears may be all steel or a combination of rubber and steel. (See illustration.) Friction-type gears are made up of wedges loaded by either steel or rubber springs. Wedges work against a fixed surface where friction is created. The longer the stroke, the greater the friction.

BABBITTED brass bearings are cheap but maintenance may run high.

Running gear consists of two main parts—the springs, and the "whaxles" (wheels and axles). Here are five ways to mount or attach the underframe on the whaxles. 1. They may be mounted directly without springs. 2. Rubber blocks may be placed between axles and underframe. 3. Elliptical springs may be used, but they have a tendency to break under repeated maximum loads. 4. Coil springs present the same



PAN-TYPE MINE CAR is designed to dump on either side with aid of hoisting device. This model is equipped with link-and-pin couplings attached to spring-type draft gear. Wheels are 20-in. diameter chilled-tread type mounted with Timken roller bearings in the hub. Note sandwich type floor construction. (Easton Car unit, CP-68)

FORMERLY, 8-WHEELED CARS were built with this diamond-arch bar-type of side frame. Trend today is to substitute the cast-steel frame. (See Cerro de Pasco model) (Gregg Car Co.)

ALL-ALUMINUM larry car above operates by remote control. It is used to stockpile iron ore from trestle. Unit is electrical trolley type.

maintenance problems as elliptical springs, but they are easier to replace. 5. Rubber springs constitute the newest method of springing rolling stock. Some rubber springs are manufactured to contain compressed air,

Axles are made three ways—square, round and hollow. The square axle is satisfactory for small cars that do not have springs. For larger cars with springs, the round axle is preferred. Round axles may be turned from stock or can be forged. If a large quantity of axles is required, a saving may be realized by ordering forged axles. Hollow axles are more expensive than solid round, but they may be specified when tare weight of a car must be kept at a minimum.

Wheels are usually made of chilled iron or cast steel for medium and small sized mine cars. (See illustration.) Generally very hard wheels are not recommended for mines having hard abrasive ore or country rock. The best solution is to ask the manufacturer to supply several types, and keep a careful record of the performance of each type.

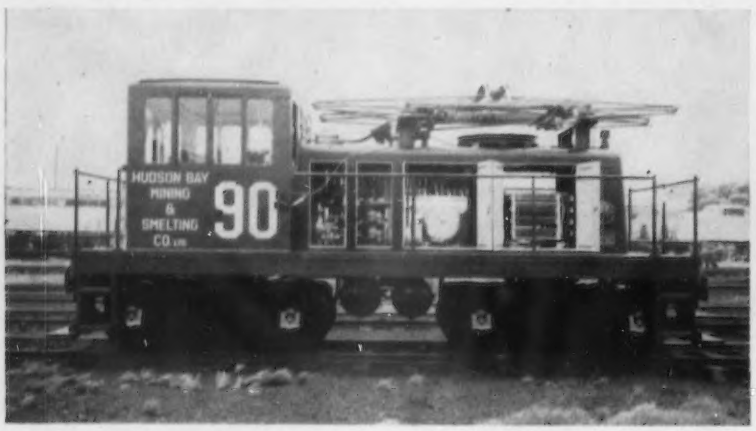
For large mine cars, more than 25-ton capacity, three types of wheels can be supplied. American railroads use both chilled iron and rolled steel wheels. The chilled iron wheels have a lower first-cost and in the U. S. they can be traded in on new wheels, but for foreign operations, this advantage is lost. Rolled steel wheels cost more than chilled iron, but have a higher scrap value. (See illustration.) The one-wear wheel is to be preferred to the multiple-use wheel because of the relatively low annual mileage covered by most freight cars. Most one-wear wheels will last 15 years or longer, and some can be expected to last for 30 years or more. Wheels are also supplied with tires which can be replaced when worn thin. There are also shock-absorbing wheels that take up major jolts before they reach the axles or bearings.

Bearings are very important from a maintenance viewpoint. Small cars can operate with cast iron wheels against a steel axle with a small amount of grease or oil. Caged rolls are cheap, but babbitted brass bearings are cheap and simple, although maintenance can be high. (See illustration.) Most modern mine cars are equipped with roller bearings because they require practically no maintenance. They also increase the load-pulling capacity of the locomotive.

If eight-wheeled cars are required, several problems arise. Formerly all eight-wheeled cars were built with the diamond-arch bar type of side frame. Chief disadvantage was that bolts had a tendency to wear and loosen up the entire side frame. The cast steel side frame is one piece, and with some of the stabilizers now available, the wear on the column is concentrated on a readily removable unit. (See illustration of Cerro de Pasco car.) Brake beams can now be made to operate in the slots in the side frame, eliminating nearly 100 parts required by the old method of brake hangers.

TROLLEY LOCOMOTIVE carries its own load. Here the 50-ton pay load also serves as ballast to achieve traction for the unit. (Differential Steel Car unit)

SWITCHMOBILE is as powerful as a 50-ton unit. (LeTourneau-Westinghouse)



ALL-ELECTRIC trolley type is shown with engine cab doors open to reveal position of controls of this 50-ton mine locomotive. (General Electric unit)

25-TON DIESEL-ELECTRIC yard and switching locomotive. (General Electric)

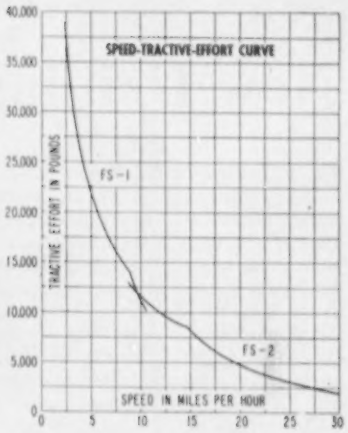
Locomotives

Electric, Diesel-Electric and Diesel. Main-Line, Gathering and Switching.

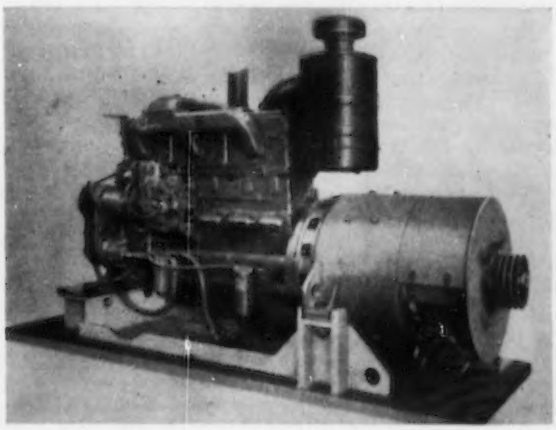
HUGE 125-TON TROLLEY locomotive for western open-pit mine. (General Electric unit)

LOCOMOTIVES REQUIRED for mining projects vary in size from small short-haul units from pit to mill, to large 125- to 150-ton locomotives pulling long trains of 50-ton cars over hundreds of miles of track. Models available to the mining industry incorporate all the power-saving, safety and control features found in standard railway locomotives. Models shown above operate as all-electric trolley types, diesel-electric, or all-diesel units. Special emphasis is being placed on braking equipment because mine haulage often involves steeper grades than normal haulage routes. See "Eighteen Ways to Protect Mine Locomotive Operators," *E&MJ*, June 1956 pp 75-77. Some mine locomotives are equipped with three types of braking to prevent run-aways—mechanical, pneumatic and dynamic braking. Magnetic relays are used in trolley types so that heavy current will not have to pass through controllers in the hands of the operator. Typical data found in the specification sheets of locomotive manufacturers is shown on the next page where a 65-ton diesel-electric locomotive for open-pit service is described.

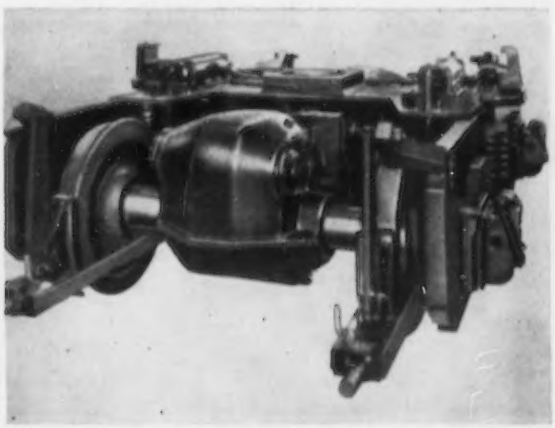
DIESEL-ELECTRIC 65-ton locomotive for open-pit service. (General Electric unit)



SPEED and tractive effort rating.



EACH OF ITS TWO 275-hp Cummins diesel engines are connected to a 210-hp dc self-excited traction generator.



RUNNING GEAR consists of two twin-axle swivel trucks. Springs are coil type. Wheels are heat-treated rolled steel.

What Goes Into a Diesel-Electric Model

STUDY OF MANUFACTURER'S specification sheets and manuals will reveal the "anatomy" of a locomotive. A few of the details for a 65-ton diesel-electric model are shown on this page. Power for this unit is supplied by two 275-hp diesel engines mounted on either end of the superstructure. These diesels drive two traction generators which supply current to four fan-ventilated traction motors mounted on the swivel trucks.

Running gear consists of two twin-axle-equalized swivel trucks. Truck frames are fabricated from rolled steel plate and welded. Wheels are heat-treated solid rolled steel with rims 2½-in. thick. Malleable iron journal boxes are fitted with babbitted brasses, and bronze thrust plates. Couplers are arranged for top operation from either side of the locomotive.

Air brakes are combined independent and automatic. A hand brake is provided for holding the locomotive at a standstill. Air is supplied by two 100-psi, 50-cfm air-cooled two-stage compressors.

Control equipment includes two master controllers, switches, contactors and relays to control operation of electrical circuits. Voltage regulars are provided to regulate generator field current, generator output and battery charging.

Under the heading of "accessories" items such as these are listed: sanders, bell, horn, headlights, lights, window wipers, cab heater and fire extinguishers.

TWO TRACTION MOTORS are installed in each of the two swivel trucks.

Specification sheets also show simplified connection diagrams of main electrical circuits, and efficiency curves plotted against speed, tractive effort and current.

New Drilling Methods—Mining's Greatest Achievement

SINCE THE DAWN of mineral production, primitive man has looked for some effective art of rock penetration. One of the early techniques was that of heating and spalling by quenching. Strangely enough, this same technique is the basis of one of the outstanding developments of today—jet-piercing, the art of penetrating rock by heating rock with a jet of high-temperature gas, produced by the combustion of hydrocarbons in an oxygen atmosphere, and cooling with a water spray. This method has been the salvation of the taconite industry which had to find low-cost methods of rock penetration to exist.

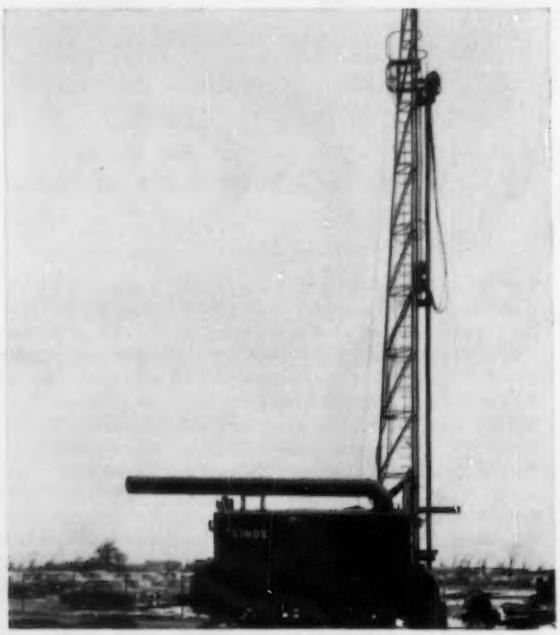
A second target is that of supplying hard materials to bite the rock. The favorable position of the diamond, highest on the scale of hardness, has long been recognized and applied. But high costs have forced mining men to look for substitutes, and these have been developed in the form of ceramic compounds and tungsten and other carbides. Alloys and heat-treatment have been additional contributions to the problem of supplying hard materials to the rock-penetration process, and much is expected from them in the future.

In addition to spalling, two main principles dominate the rock penetration field: (1) pounding or percussion, and (2) grinding by rotation. Recently a European process has introduced a combination of pressure grinding and percussion which has attracted the attention of mining men. (See p 83.)

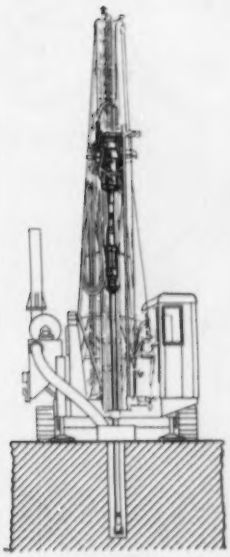
No matter how rock is penetrated, the process requires power. The deeper the hole, the more difficult is it to supply the power. Rotation through a drill stem has been the conventional solution. But forward-looking technicians are not satisfied with the efficiency of this method. In France and Russia, reports are coming out that power to rotate the bit may be transmitted to the bottom of the hole without rotating the entire drill stem. In the U.S., veiled hints are made that: (1) a high-frequency drill is being developed using electrical principles, but that the chief obstacle is getting the power down to the bottom of the hole, and (2) a hydraulic method is being developed to produce high-frequency vibration of the rock bit.

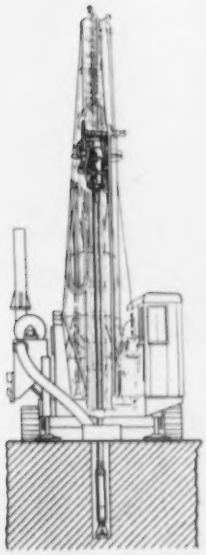
How are drill designers responding to all of these new developments? Very well. They are incorporating the new principles as rapidly as they can be developed economically and practically. For instance, Ingersoll-Rand has introduced a three-in-one drill unit which drills by: (1) percussion, with the percussion drill down the hole; (2) by percussion, with the percussion drill out of the hole; and (3) by rotation with hard-biting bits. Similarly, Bucyrus-Erie has added to its conventional line of churn drills the jet-piercing unit, and a new rotary drill.

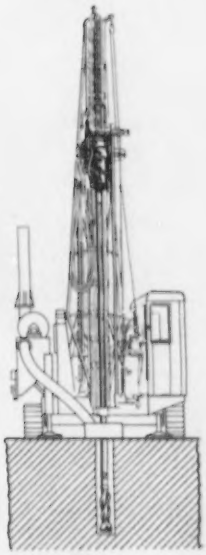
The recent trend of the oil industry to go into mining, and the mining industry to go into oil, is going to speed up the development of new drilling techniques. Note the big invasion of rotary drills in mining as a result of the uranium boom.



JET-PIERCING. The commercial machine at left is a Bucyrus-Erie JPM-3 operating at the Humboldt iron mining pit. The flame is produced by burning petroleum-base fuel to produce a high-velocity, high-temperature flame with the aid of oxygen. Water is supplied through the stem to cool the burner, and to form steam as it comes in contact with the rock face and the products of combustion. This produces the desired spalling action. The unit shown at right is a development jet piercing model by the Linde Air Products division of Union Carbide & Chemical Corp. which pioneered the design of jet piercing rigs.

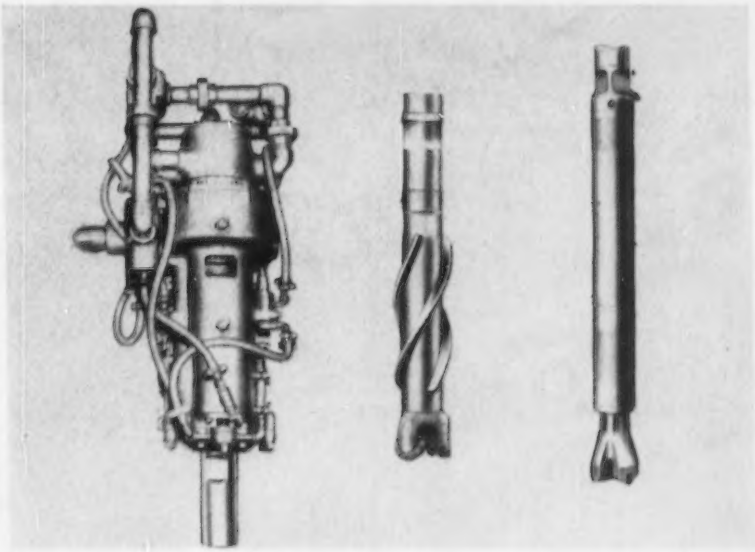






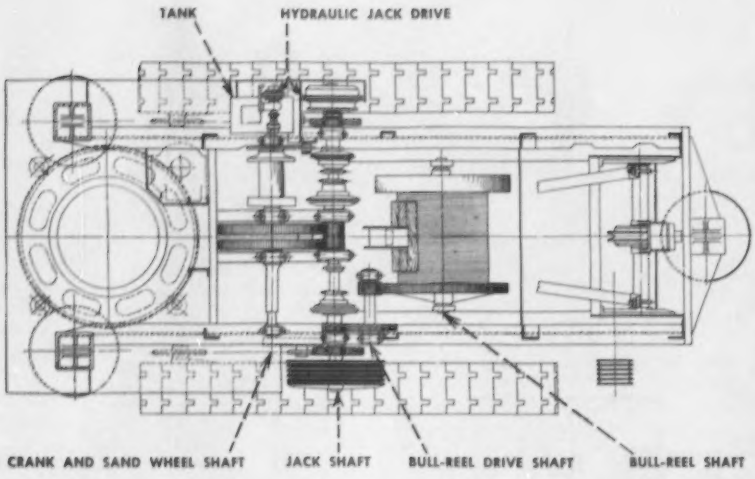
Three-in-One Drill

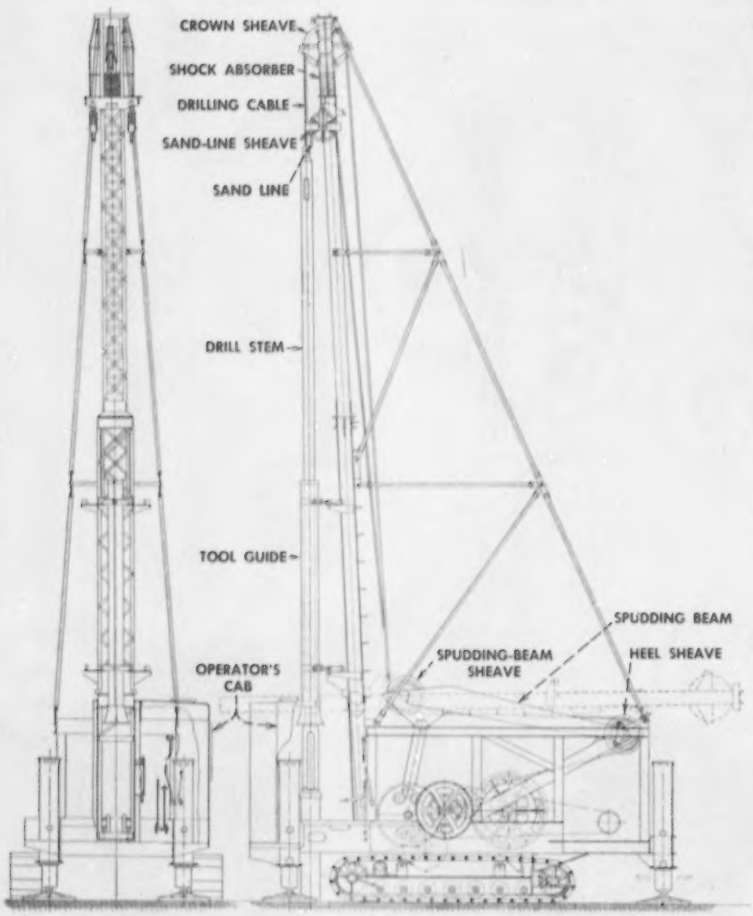
This drill offers three methods of rock penetration: (1) percussion drilling (left) with the machine out of the hole, (2) percussion drilling (center) with the drill down the hole, and (3) rotary drilling (right). Rotation is supplied by the motor shown in the illustration at right which also shows the down-the-hole percussive unit, and the bit and spirals for hole cleaning for the rotary attachment of the drill. Compressed air is produced by a Gyro-Flo rotary compressor which delivers air at 110-lb for powering the drills and blowing the holes. This machine may be either tractor-mounted or truck-mounted depending upon terrain. The air-powered crawler drill can go up grades as steep at 30%. Cuttings are collected in a hopper providing good stemming material. (Ingersoll-Rand Co., Drillmaster Model.)



Auger Drills

Penetration of unconsolidated overburden and decomposed rock is usually required for exploration projects, but it is also required in certain open-pit operations. Two truck-mounted models are shown here. The Continental Equipment model at left will penetrate earth to a depth of 100 ft, and rock with diamond bits to a depth of 300 ft. The Mobile Drilling Inc. model at right will core to 200 ft and auger to 75 ft at any angle. Air or water may be used with the hollow stems to remove cuttings.



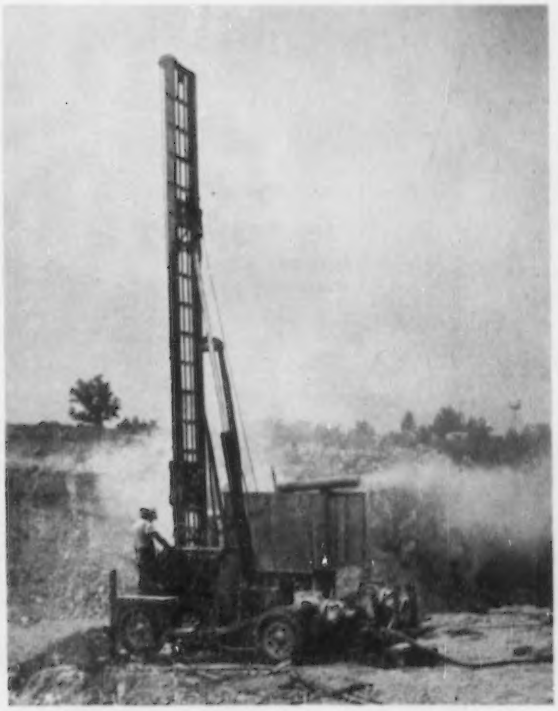


CHURN DRILL. Major parts of a hard-hitting churn drill are shown above. This unit will put down 9- to 12-in. holes, and carries 6,000 lb of tools. This model is used on Mesabi iron formations. (Bucyrus-Erie, Model 50-T)

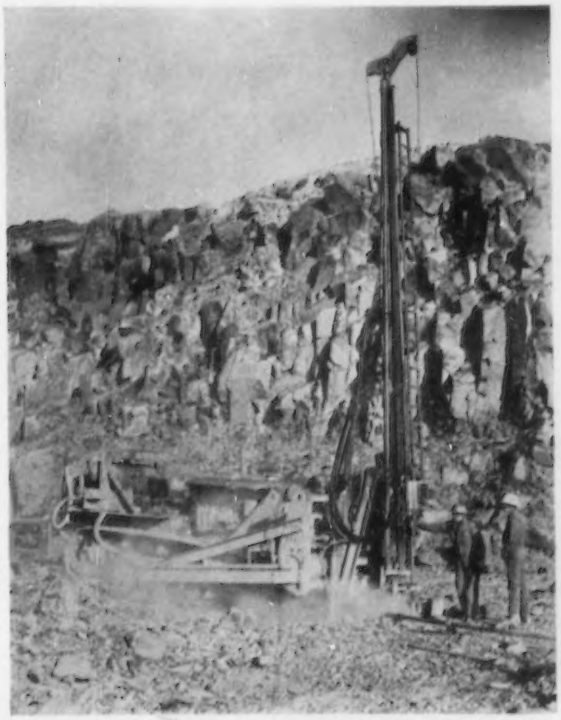
Turbo Drilling

RUSSIA AND FRANCE are both working on turbo-drill models which may have tremendous impact on deep drilling. Although both units are aimed at solving oil-well drilling problems, they represent a principle that may have application in exploration and open-pit drilling as well. Instead of turning the entire length of drill rods, all energy of the machine is concentrated on turning the rotary bit through turbine action of a unit at the bottom of the hole. Two views of the French turbo-drill are shown above. An American firm, Dresser Industries Inc., is reported to have obtained 10-year rights to manufacture a drill patterned after a Russian design. Penetration of both units is said to be 8 to 10 times as fast as that of conventional oil-well drills.

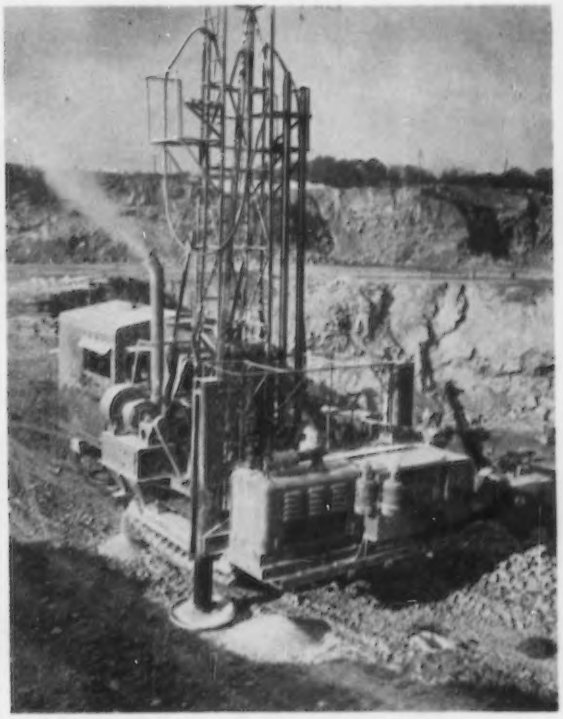
ROTARY DRILL. This drill has air compressor and pump for wet or dry drilling. (Winter-Weiss Portadrill)



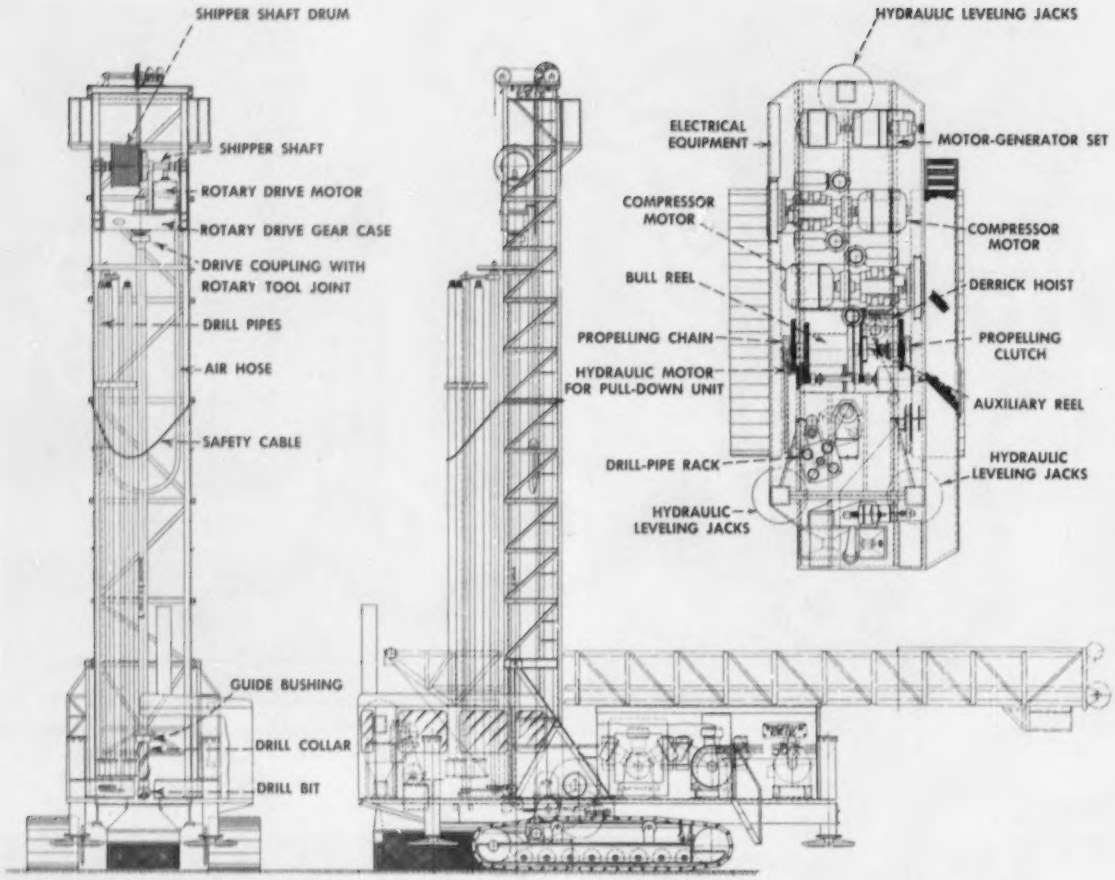
PERCUSSION DRILL designed to go through the hardest of rocks to 50 ft or more. (Joy, TWM-5 Challenger)



CRAWLER-MOUNTED PERCUSSION DRILL can be installed on customer's tractor. (Joy Challenger TF-500)



ROTARY DRILL will drill holes up to 7⅞ in. in dia, and to depths of 50 ft or more. (Joy Heavyweight 58-BH)



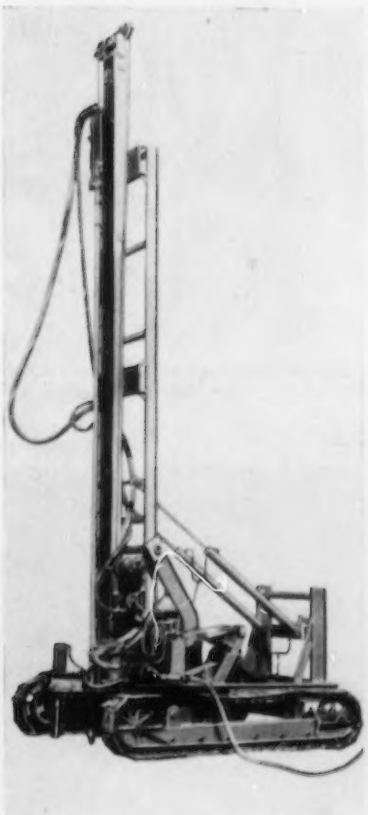
ESSENTIAL PARTS of a large open-pit rotary drill with cyclone cutting removal. (Bucyrus-Erie, 50R)

DIESEL-POWERED ROTARY mounted on tractor has power-flow pull-down for constant pressure. (Mayhew model)

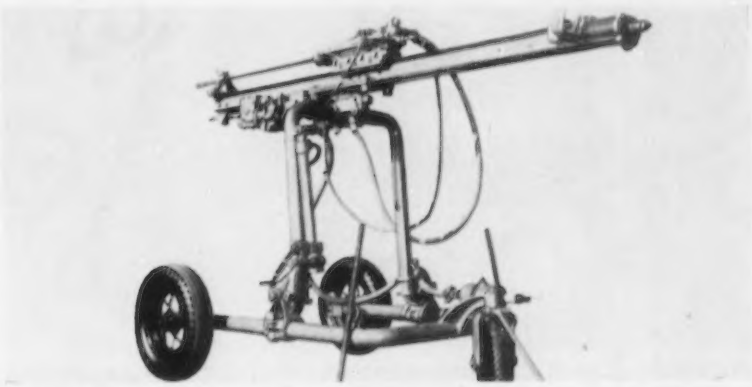
TRUCK-MOUNTED ROTARY will drill 5⅝-in. holes down to 500 ft with 2⅜-in. drill rod. (Reich Bros., 300)

SELF-PROPELLED ROTARY rig produces pneumatic power for movement of rig and drilling. (Schramm, Pneumatractor)

CAT-MOUNTED COMPRESSOR and jumbo feed two heavy drills of this open-pit jumbo. (Le Roi Cleveland units)



PORTABLE ROTARY teams up with wheel-mounted portable compressor to put down drill holes for open-pit blasting. (Gardner-Denver)



WAGON DRILL for vertical and horizontal drilling. (Thor, BW-2)

PERCUSSION wagon drill for bench-drilling in open pits. (Gardner-Denver)

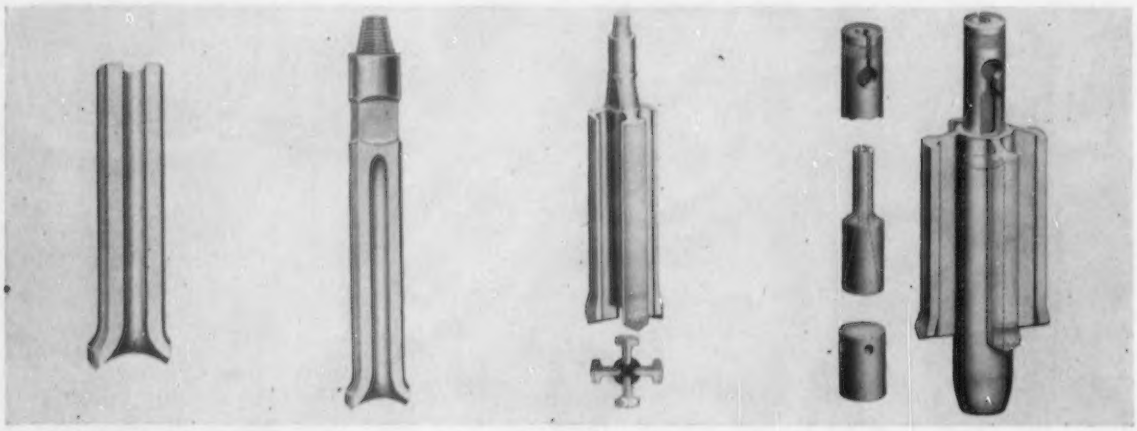
CHAIN-FEED drill puts down 4-in. holes to 25 ft. (Joy, medium weight)

TUNGSTEN-CARBIDE Tri-cone bit for I-R Roto-Master and Quarrymaster drills.

SIX-INCH tungsten-carbide bit for I-R down-the-hole drilling rig.

TUNGSTEN-CARBIDE 4¼-in. bit for I-R Powermaster drilling rig.

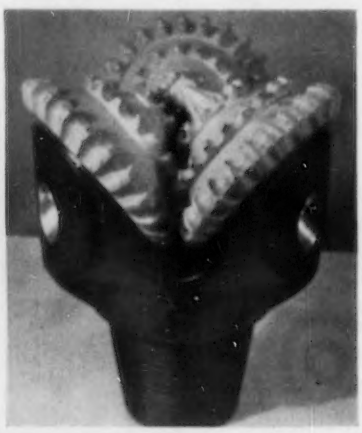
FOUR-POINT tungsten-carbide bit, 5¼ to 6¼ in., for I-R Quarrymaster drilling rig.



CHURN DRILL TOOLS. Replacement section at left is forged and heat treated. Drill bit, center left, comes in three diameters: 6, 9 and 12-in. Star bit, center right, is hard-surfaced for larger holes. Reamer-type bit at right is used for large-diameter holes for ventilation, pumping etc. (All types shown above made by Spang and Co.)

ROTARY BIT in action at bottom Bucyrus-Erie 50-R Rotary drill.

THREE-CONE bit for shale, red beds, and soft formations. (Varel, Type V3)

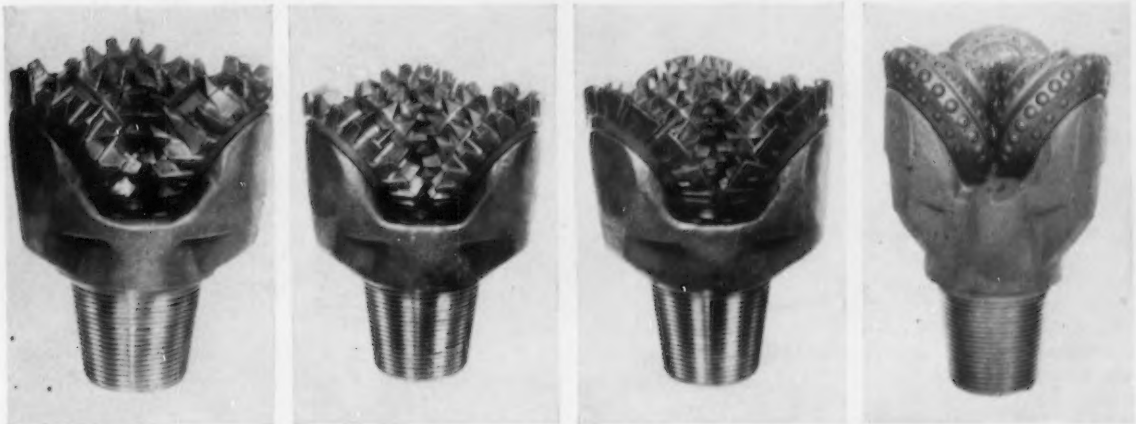


REPLACEABLE CONES in three-cone roller bit. (Central Mine Equipment Co.)

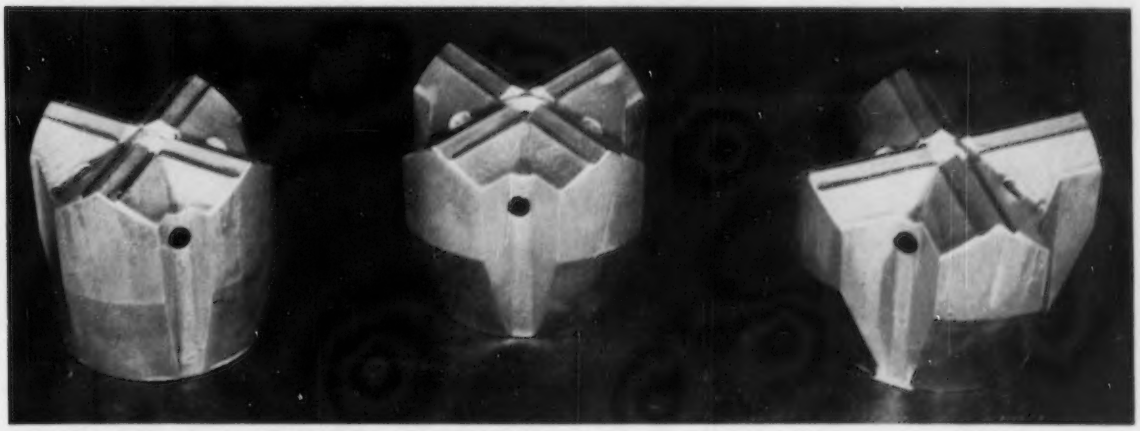
FINGER BIT for broken shales and limestones. (Varel, Type XH)

CEMENTED CARBIDES in rotary bit for hard rock. (Varel, Type CC)

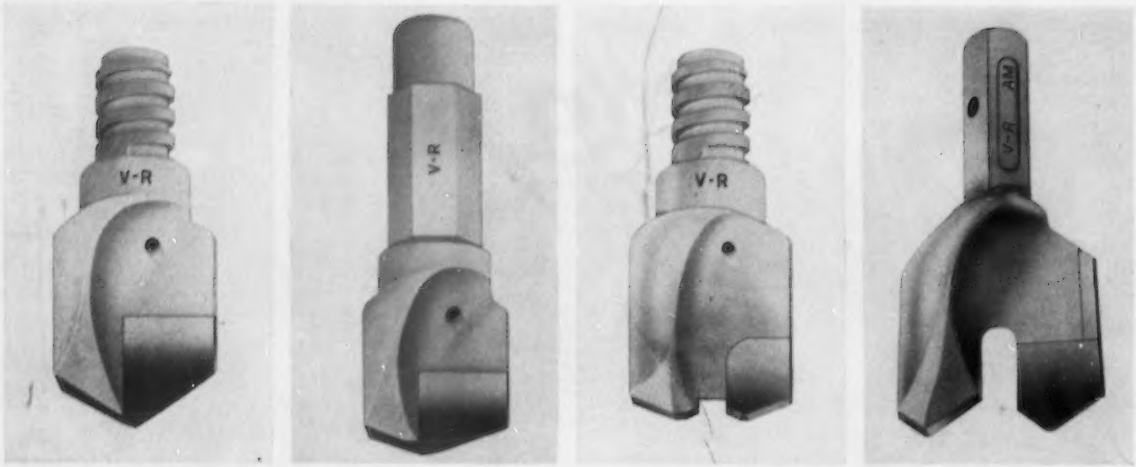
HEAVY-DUTY cemented carbide in cast body. (Varel, Type CCN)



TRICONE BITS. Types shown, left to right, are: OSC for soft to medium formations; OWC for medium hard formations; WR7 for hard abrasive rock; RG-2J jet bit for extremely hard rock. (Hughes Tool Co. products)

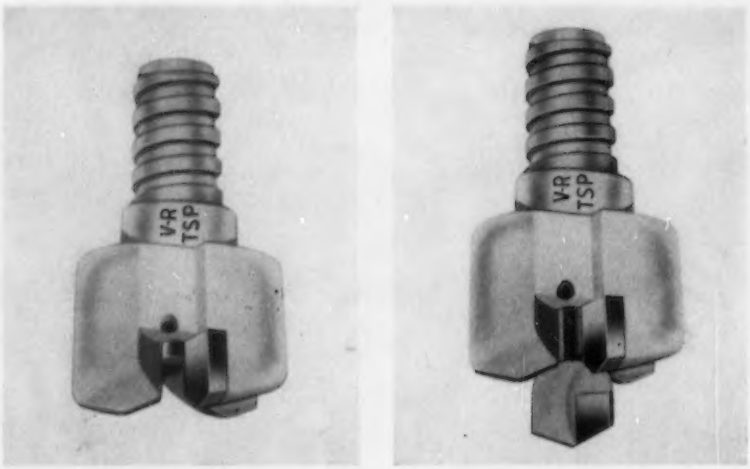


TUNGSTEN-CARBIDE INSERT rock bits for drilling large size percussion holes in pits and quarries. Bit diameters above, left to right are: 3¼, 4 and 4½ in. "X"-design prevents squaring of the hole. (Joy Manufacturing Co.)



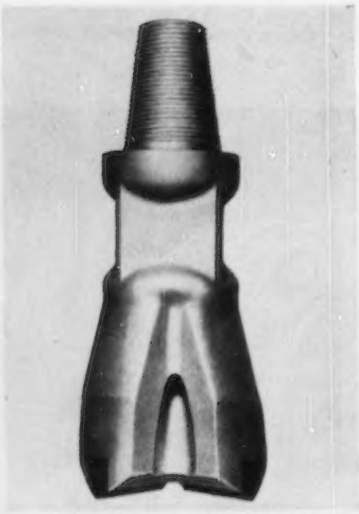
T-C Rotary Bits

TYPES SHOWN ABOVE, left to right, are the SP bit for medium hard dolomite and decomposed granite; SPH with hexagonal shank; SPS for faster drilling speeds in shales; and type AM which is a two-prong bit for dry-drilling with flighted rod in softer or ravelly materials. Type TSP at right is a three-prong bit for drilling vertical holes of larger diameters. Type TSP, far right, is a three-prong bit with pilot. Tungsten-carbide rotary bits of these types, particularly the spade-heads, have proven very successful in iron mines and copper mines of northern Michigan, and in Western chrome operations. All types shown made by Vascoloy-Ramet Corp.

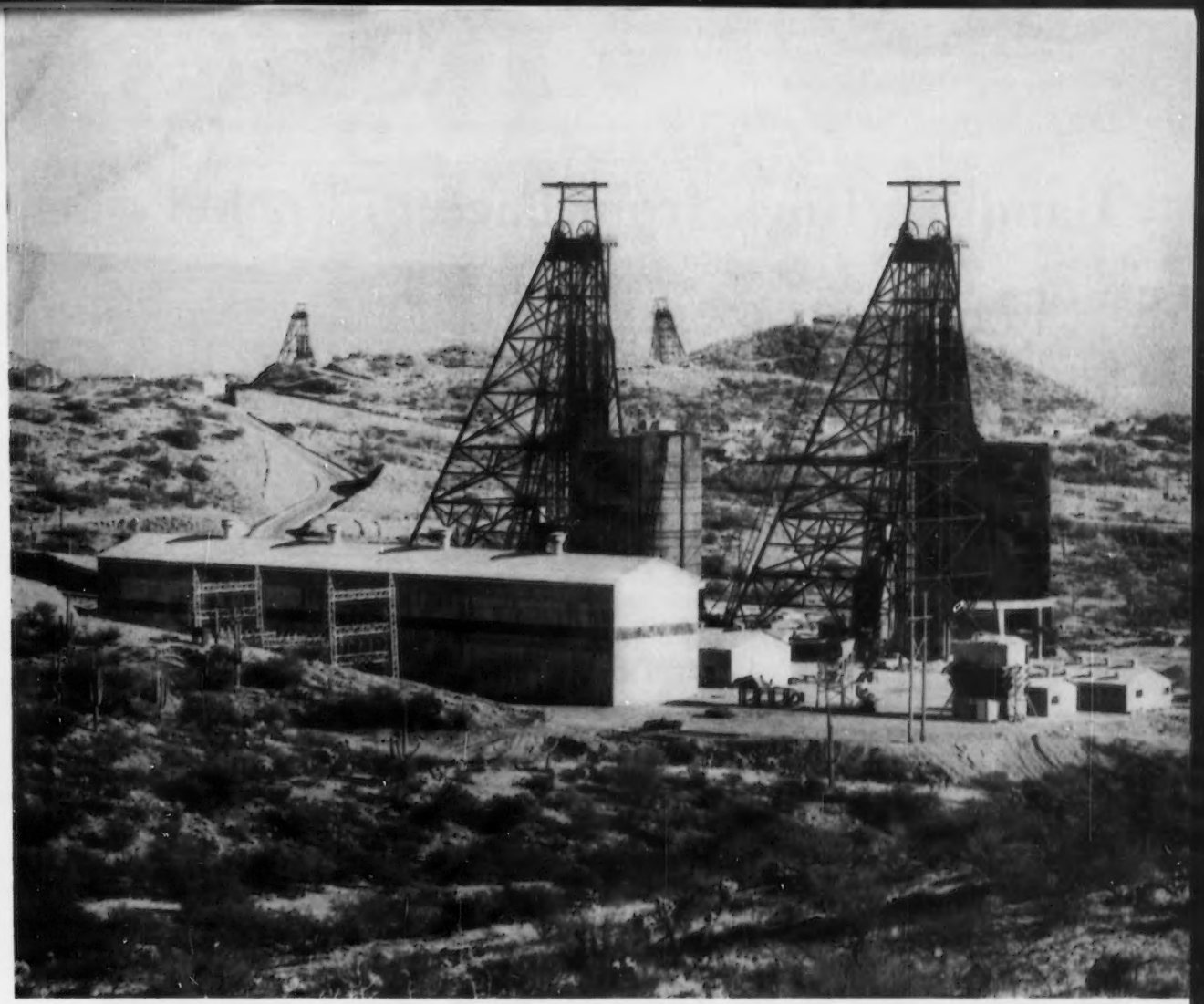


AIR-OPERATED bit grinder for dressing Carset Quarrymaster bit. (Ingersoll-Rand)

FISH-TAIL screw bit for auger drilling in sandstone. (Peterson Engineering)



SIX-IN. tungsten-carbide bit for large percussion drills. (Brunner & Lay)



AMERICA'S NEWEST big underground copper mine—San Manuel

Perspective on Underground Mining

THIS UNDERGROUND MINING SECTION is primarily designed to be an up-to-date guide to planning. The limited size and variable nature and shape of "hard rock" ore deposits are sometimes cited as an obstacle to mechanization but on the following pages automatic power devices are prominent. Although fundamental theory has not been probed very deeply, the panoramas of equipment are carefully selected to give emphasis to basic types—epitomizing fundamentals by applications. Of course, not every type made has been shown, but most manufacturers make a variety of basic types and welcome inquiries on detailed specifications (see Buyers' Guide section).

It is apparent that underground mining needs more operations research of the kind being applied to exploration and surface mining, to give us better solutions to the complexity of factors. The starting points — numerical values — are being supplied. Studies—so far mostly supported by oil well drilling groups—on the fundamentals of making a hole in rock, have resulted in new concepts as well as numerical values. Tests of drill steel, such as by the Canadian Department of Mines, are giving more practical and numerical answers to life expectancy, et al. And a recent AIME transaction tells of studies concerning the crushing efficiency of explosives—a step toward precise calculation of the optimum fragmentation to be alloted to blasting. But we need better numerical correlation of basic factors. Until this is done, integrating all the ideas and equipment into the over-all scheme must be an underlying attitude—for the ultimate criterion is lowest cost (dollars) per unit (weight or volume) of *final* product, not necessarily lowest cost component.

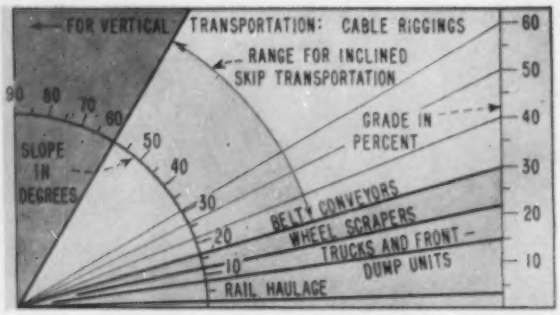
Handling Rock from Face to Pocket

HANDLING MUCK cannot be considered an independent variable in mining's "formula for profits." Failure to relate means of handling to degree of blasting fragmentation and abrasiveness of ore has forced more than a few mines to an "agonizing reappraisal" of mining methods. Some have failed to realize what happened when they tried to apply highly successful short-haul equipment to long-hauls and their expected cost cuts never materialized. Still others bogged down when they tried to make a direct ratio between *size* of a single piece of equipment and *rate* of production. This factor is especially critical when working with the intermittent types of equipment and methods so common to mining.

Of course, there are many examples of non-conformity paying off handsomely. Application of new or old devices to new situations is the engineer's job. Perhaps this panorama of muck handling equipment will help increase profits through reason rather than trial-and-error with its too frequent result of money down the drain. It starts with loaders and excavators, followed by units increasingly more transporting in nature.

Hydraulic transport, or pumping, of muck is not shown. It has had some use and where power and water are abundant it probably has merit.

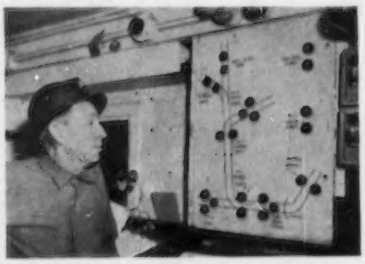
Basic consideration in planning should be to keep all equipment working all the time with allowance for preventive maintenance.



ONE SELECTION FACTOR for method of transporting muck is slope angle, which may be dictated by lay of orebody.

Control Speeds Job

Audible and/or visual communications must be part of any modern handling system, not only for efficient normal operations but also for emergencies. Local or remote controlled traffic lights are available. Flashing lights and horns can warn of chute blasting or other dangers. Limitations on underground radio are largely overcome by carrier currents on power lines.



NERVE CENTER at more and more mines is map in central control room.

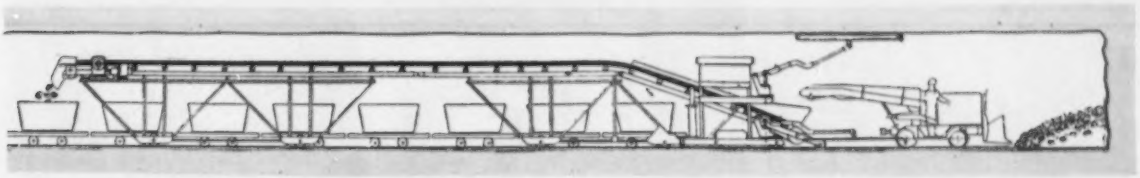
CRANE AND PIT FACILITIES and good lighting are desirable in shop. Storage of tools and supplies must make housekeeping easy. Roving servicing crews, equipment with centralized lubrication, and hardfacing wearpoints all aid efficiency.

Scheduled Maintenance Will Cut Costs

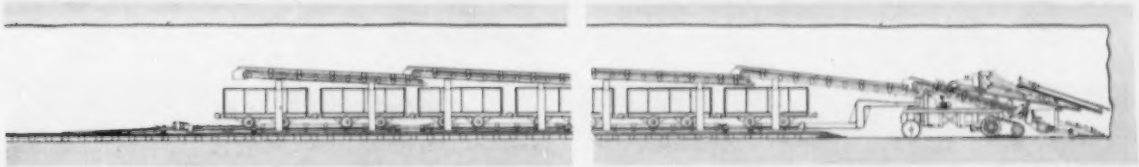
Pulling a piece of equipment into the shop for scheduled preventive maintenance when it's working well has caused many a snicker. But many a supervisor has had the last snicker when cost sheets are added up.

Systematic maintenance is based on accurate records. Most manufacturers can give an initial servicing schedule for their machines. Later, schedule can be adjusted to fit records. Records also show weak points and help evaluate redesigning costs.

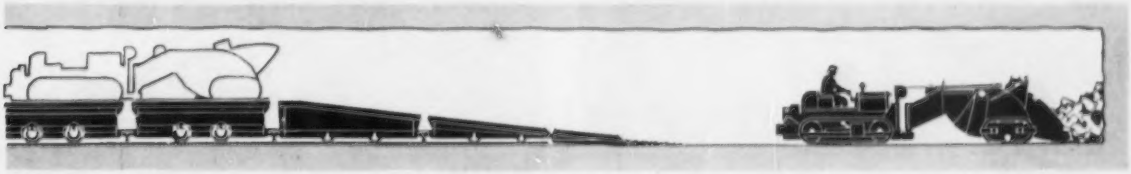
In addition to schedules and records, administration of maintenance program should set limits to job of operator, mobile crew and local shop for efficient use of labor.



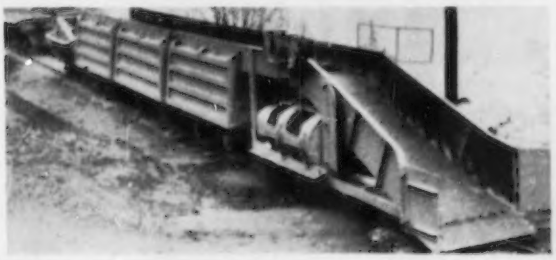
OVERCAST LOADER with short belt conveyor attachment is used with longer separate belt on carriage to fill string of cars.



GATHERING ARM LOADER with attached hydraulic drill arm permits drilling while loading long train with sectional belts.



GISMO self-loading transport fills train by riding treadway along top edge of low bottom-dump cars in fairly low drift.



SLUSHER and ramp in Sweden has electric hoist on side and

ledges on lip of cars to support bucket—also needs sheave at face. In U. S., Whup D'Whup uses overcast loader to fill hopper car (with yoke for sheave) and air slusher hoist on rear car.

Set-Ups Aim For Fast Loading

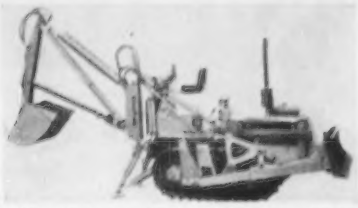
Goal in drifting is to cut car switching delays by various combinations of loaders, surge bins, special cars and car-transfers, and getting entire round on one train.

SINGLE extensible boom on Excaloader cuts headroom needs.

SHORT BOOM is adaption of standard shovel for mine use.

Power Shovels Operate at Lowest Cost

Excavator-loader proven to have lowest operating cost per ton is the power shovel. It has found wide use in open stopes, especially in thick, flat-lying deposits where rate of production is fairly high. Short booms on some models, as well as "straight-line" operating arrangements on others, keep headroom requirements moderate. Both diesel and electric powered units are available to fit ventilation conditions. (See Open Pit section)



SMALL hydraulic back-hoes work too.

EARLY development was like power shovel. Another had attached conveyor. Vertical lift type was cable operated.

WHEELED unit moves fast on smooth bottom. (Hough)

CRAWLER, for rougher spots, has special bucket here. (Drott)

OVERDUMP type need not swing, but takes headroom. (Athey)

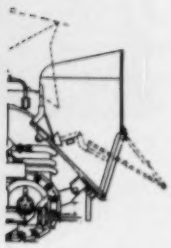
Scoop On Tractor Is Handy

Front-end loaders are usually hydraulic type on diesel tractors although there is an air model (below) and a truck unit (see Open Pits). Since whole unit crowds and swings, efficiency is less than power shovel. But being very compact and maneuverable, it is common in smaller flat-lying mines.

ROLLING bucket cuts swing and headroom. (Merton)

RAIL unit is standard. (Gardner-Denver)

CRAWLER fits trackless schemes. Hopper adds transport aspect. (Eimco)



Overcast Type is Compact

Air-operated overcast tractor-excavator-loaders on rails are the standard in mine development work. Many sizes are made. More versatility has been added by the introduction of crawler mountings. Wheeled types and electric units are available, and so is a larger diesel model (see Open Pits). Attachments for the basic tractors fit almost any mucking or loading situation found in mining.

SELF-LOADING trailer for diesel tractor is cable operated. It is pushed into muck, then scoop swings up so rock slides back into bottom-dump body. It has number of advocates in trackless mining for short hauls. (Sanford-Day) (See Jumbos)

GATHERING ARM loader continuously sweeps—with pair of arms (Joy, above) or paddles on chain—ore into chain-rake conveyor as crawlers crowd into muck. It has low height and high output. Use has been widest in lighter, less abrasive ores.

SLUSHING RAMP on crawlers is used to load truck in stope.

Slushers Are Versatile

For gathering and transferring muck, power-eating slushers are replacing more and more elevation-eating raises. Better control of production rate is probably big factor. In stoping wide areas, three drum hoists (two tail ropes) give a two-dimensional coverage. As a loader—with ramp or chute—they are far-reaching. Attitude and regularity of bottom have only minor effect on efficiency, although these and wear are considerations in scrams. Blocks or sheaves are an essential part of the set-up. Various combinations of standard and snatch (one side opens) blocks make even slushing around corners feasible. Wedges generally locally made, make pinning blocks an easy job.

SLUSHER HOISTS in smaller sizes, under about 20 hp, are often compressed air powered (left, Gardner-Denver); about 100 ft is maximum efficient range. Electric power is used for larger sizes (middle above, Ingersoll-Rand) which go to about 150 hp for up to about 200 ft. Tandem drum hoist minimizes width of hoist station (above right, Vulcan-Denver). Top rope speeds for all are about 450 fpm.

SLUSHER BUCKETS are made in various sizes and shapes using structural shapes and plate cast steel by local shops as well as manufacturing specialists. Early box-like style, still used in special cases, carries muck on bottom plate (above). Reducing bottom area cuts wear by having muck ride on itself and design becomes more like curved hoe with sides (middle two). Cast steel styles are rugged and generally heavier, giving good bite in coarser muck (top right). Folding hoe cuts drag on tail pull (lower right, Eimco). Crescent is light, usually used for finer muck on surface, and drags back easy (bottom, Sauerman). Cable attachment varies. Clamps, wedges and simple rope hitches are used.

Conveyors Need Little Tending

Gathering, transferring and transporting muck becomes largely automatic with conveyors. Usefulness of short units can be seen in frequent use as loading component of excavator-loaders, and as feeders for crushers, bins, etc. Sectional units give maximum flexibility, especially when self-propelled. The continuous action lends itself to high steady rates of production primarily. High ratio of load to transporter weight gives low costs.

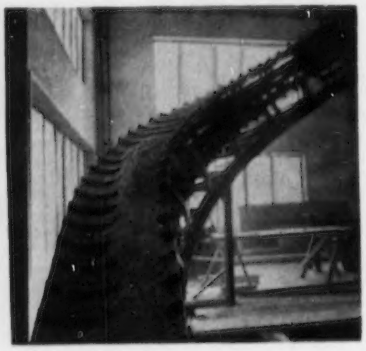
To minimize wear, loading set-up must be designed to get muck on conveyor at near same speed and direction. Devices now make changing discharge point easy.

For belt types, fines on bottom and use of flexible idlers are cushioning aids at loading point and along belt. Few supports are needed with recent unit using flexible idlers supported by two wire ropes (Goodman). New extra-long belt designs use separate pulling element.

BELTS, most common conveyor, are made from rubber compounds and cloth and/or wire, and even flat steel sheet (Sandvik), to meet various conditions of load and length of haul.

CHAIN & RAKE is used mostly for shorter distances and less abrasive ores.

SHAKING PAN is other type for shorter haul but wider range of ores.



FOLDED BELT is new style of type using series of pans pulled by chain.

Trucks Are Flexible

Self-contained aspect of truck haulage promotes its use. Ventilation is principal hurdle. Other pages on underground mining show more examples of many means of dumping and powering, and use of trailers. Except for very largest, those shown in Open Pit section are also used.

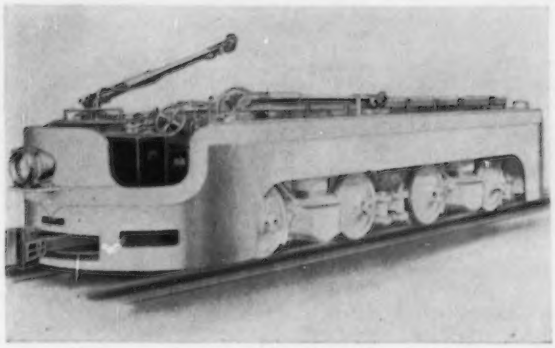
CABLE dump turns sharp. (LeT-Westghs)

ROCKER dump gravity spills. (Koehring)

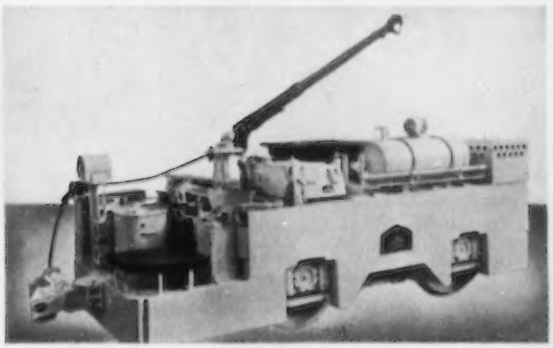
ELECTRIC unit has trolley. (Kenworth)

SHUTTLE CARS with conveyor bottom are diesel (Dart) or electric cable reel (GE).

CLEANING OUT sticky ore can be solved. Maintaining roadways, etc. is done with dozer (Eimco) or grader (Cat.)

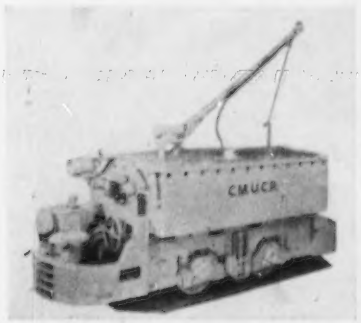


TROLLEY locomotives are highly efficient. (Diff. Steel Car)



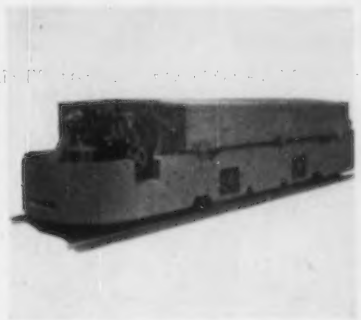
CABLE REEL permits off-trolley-wire operation. (Westghse)

Rail Haulage Gives Rock-Bottom Operating Costs

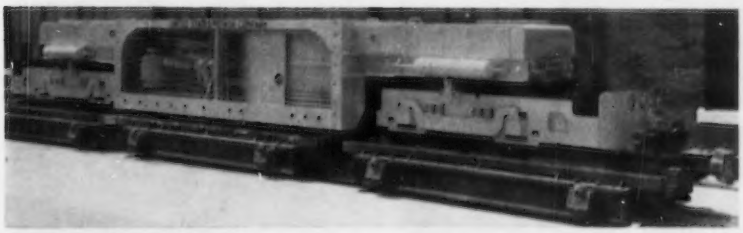


COMBINED trolley-battery is handy.

SMALL battery is versatile. (Mancha)



LARGE one fits bigger schemes. (Jeffrey)



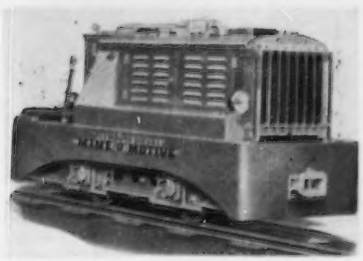
Railroading is major element of mining. It has maintained its eminence because of its low-cost, dependable operation. For best results, it requires careful design of the many components making the complete system.

DIESEL-ELECTRIC—40 ton, 420 hp—is example of big units (GE). Multiple tandem electric units are big too.

Diesel and Air Types Fit Special Schemes

DIESEL locomotives for underground generally need exhaust washers. Both smaller sizes—2-ton, 30-hp (left, Mancha)—and larger models—10-ton, 79-hp (below, Plymouth)—have hydraulic torque converters.

AIR locomotives can move when tank pressure drops as low as 20 psi before needing recharge from air line. Little model makes caging easy (right, Universal). Larger one weighs 1½ tons (below, Eimco).



Electric trolley haulage will usually give lowest costs, but often wire is inconvenient or too permanent. Cable reel equipment is a limited range solution to power distribution problem. Battery locomotives solve it but facilities and time for charging are factors. Diesels are flexible if ventilation is satisfactory. Air trammers have size limits, but very low costs.

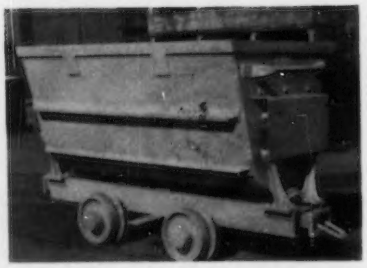
END DUMP has swings and spring or straight-through drawbar. (Card)

GRANBY TYPE is automatic side dump and comes in many variations. (Mayo)

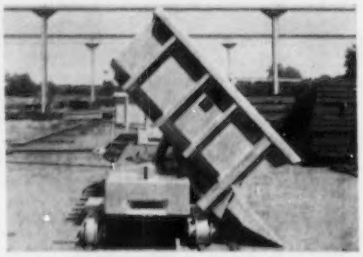
Cars Fit Any Condition

Selection of means of transporting muck is a problem that involves a wide variety of factors, many of which do not lend themselves to mathematical solution. Once rail haulage has been decided upon, selection of the type of mine car can be rather precise. In the section on earthmoving in Open Pits there is a discussion of mine car design which applies equally well to underground types. In the November 1955 issue of *"The South African Mechanical Engineer"* a paper by R. P. M. Holliday gives a very careful analysis of underground mine car selection. One of his recommendations —for efficient utilization of equipment, the largest practical car should be chosen—is a conclusion that many mines have reached.

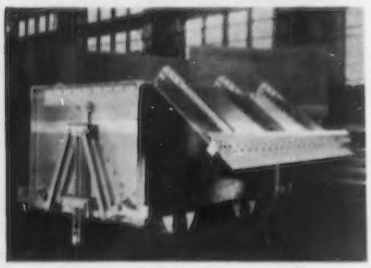
Automatic couplers, spring-supported bodies and roller type bearings are increasingly in use. For low headroom, wheels are recessed in wide body and put on stub axles.



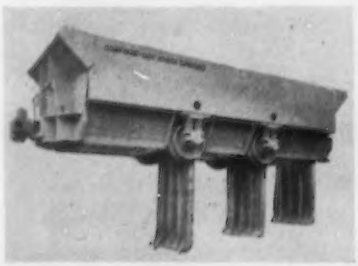
ROCKER DUMP, also hand dump, has no doors, thus no fines spillage. (Card)



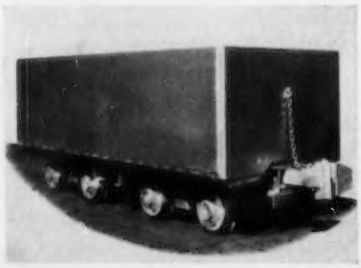
SIDE DUMP with bottom-hinged door has air ram to tip. (Diff. Steel Car)



GABLE BOTTOM needs no tipping device but capacity is somewhat less.



BOTTOM DUMP has high capacity and cleans well if wide. (Sanford-Day)



ROTARY DUMP body eliminates fine spillage but needs big dump. (Bethlehem)

CAMELBACK, standard for Granby, can be hinged for selective dumping.

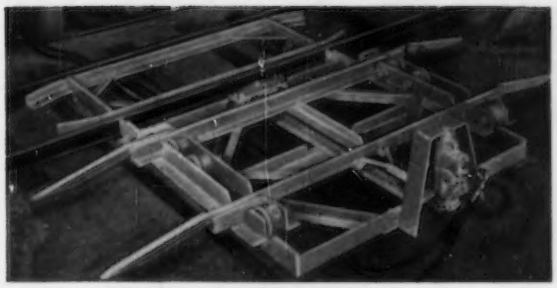
AIR CYLINDER is fast acting and can give push or pull with cam or hook.

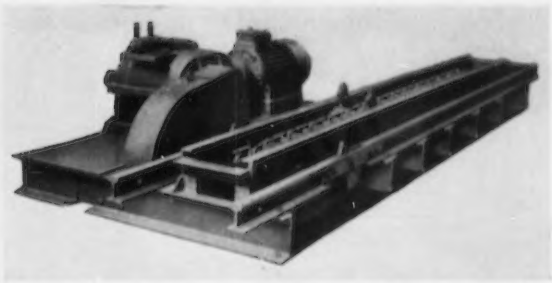
ROTARY generally works well but good rotating car coupling is yet to come.

Dump Must Match Car

Although car type and dumping arrangement go pretty much hand-in-glove, there are still several alternatives to the mechanics of dumping: by cam (or ramp) and train movement; by external power devices; by internal power devices; or even by manual effort. Dumps for tipping-type cars should have some accessory to prevent overturning or at least to rerail them. A bumping block or vibrator attachment can help with sticky muck. And a hook or pneumatic stinger can aid with ore tending to bridge or wedge.

AIR operated unit is used to free sticky muck or large boulders.

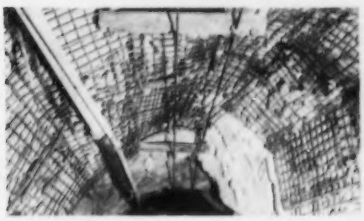




CAR TRANSFER switches cars in tight space. (Amer. Mine Door) **CAR SPOTTER** moves cars short distances. (Hausherr)

Auxiliary Devices Boost Efficiency Of Rail Haulage

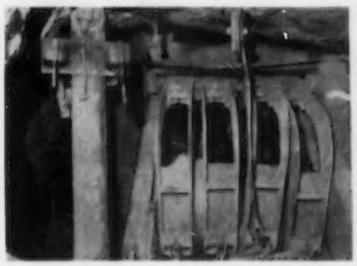
Innumerable aids for underground railroads have been developed. Many have been adopted from commercial surface systems. Others are designed especially to meet mine situations. Units above, plus lifting type transfers and automatic doors and switches are only a small indication of the equipment available.



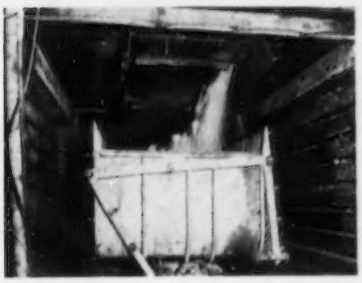
TROLLEY wire and ground are held with rock bolts. Stanchions are neat. "Cushioned trolley" hangs on feeder. (Ohio Brass)

Haulageway Design Developments Need Watching

Ground support, drainage and roadway design are elements common to all underground haulage. Ballasting, ties and track must be added for rail haulage, plus rail bonding and power distribution if electric trolley. Current practice often gets little publicity, and even a brief review prior to planning might pay off well.



CHUTE GATES are often power-operated now. Rigid fingers, free-hinged and weighted fingers or weighted chains are used.

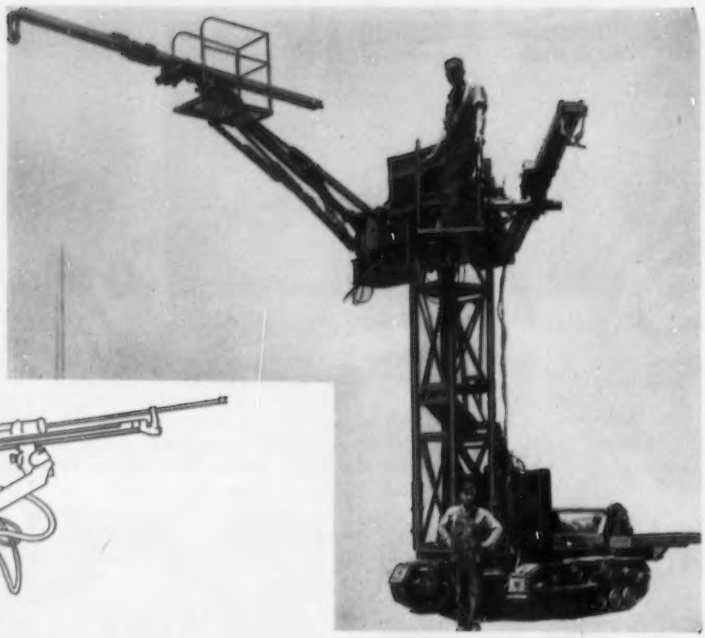


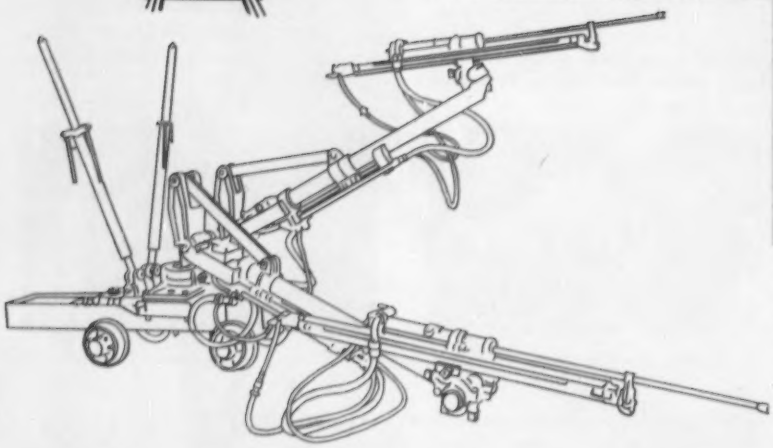
SET-UP for slushing directly into cars often includes remote controls.

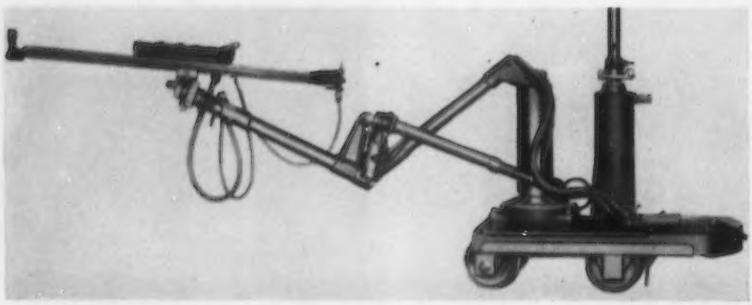
Chute Styles Are Varied

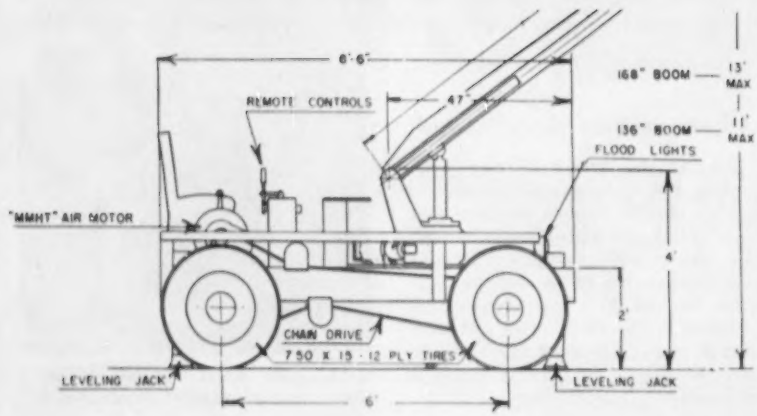
An essential feature of most underground muck handling systems are gravity chutes. Failure to plan them to fit muck and operating conditions can cause cost-raising bottlenecks. Usually they are of local design and strive to cut bulk and wear. One postulate is to transfer load and wear to rock opening itself as much as possible. Resistance to blasting forces is an important consideration.

SOLID ARC GATES as well as guillotine-type have place in many schemes.









Jumbos Speed

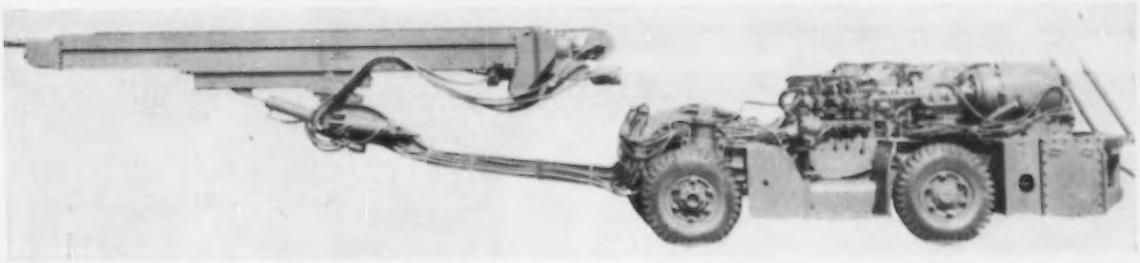
Tunnel jumbo, upper left, is designed to carry heavy, hard-hitting, high-speed drifters. Drilling is carried on by five drillers working simultaneously from platform and track level. Ingersoll-Rand Co., New York, N. Y.

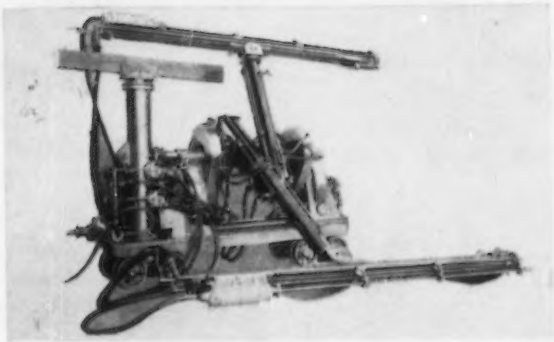
Track-type boom jumbo, second left, is equipped with booms mounting heavy drifters. Mechanical boom arms position drills accurately and rapidly. Two pneumatic spuds on drill carriage pin the truck and wheels securely to the mine track. Ingersoll-Rand Co., New York, N. Y.

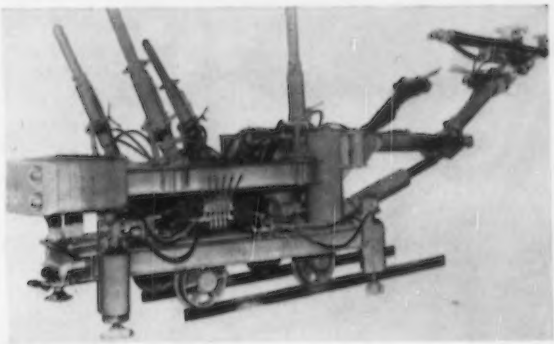
Single-boom jumbo, third left, is completely air operated. Note hoses branching from air line oiler on jumbo. Piston-type vertical spud near center of truck holds unit to the rails. Pneumatic extensible arm positions boom carrying drill. Note how the air and water lines feeding the drill are installed within the boom arm. Similar models are available mounting two drills. Thor Power Tool Co., Aurora, Ill.

Mobile Jumbo, lower left, is propelled by air motors to drilling position. A hydraulic pump driven by an air motor powers the piston which positions the boom. Hydraulic positioners operated by remote control lever are provided to swing and dump the machine. Unit is equipped with four hydraulic leveling jacks and headlights. Gardner-Denver Co., Quincy, Ill.

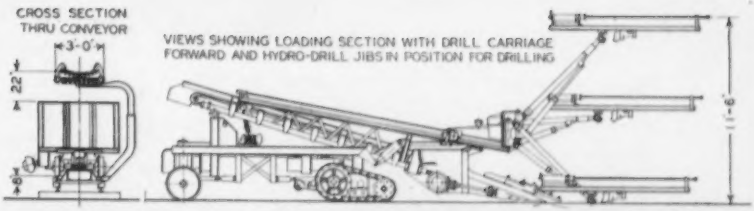
High-back jumbo, above, will drill holes in a 32-ft high by 24-ft wide pattern. Mast folds to permit passage through 12-ft passage. Crawler may be driven by electric motor or compressed air. Rogers Iron Works, Joplin, Mo.







Mine Drilling



Rotary drill, top, is a demonstration model for penetrating medium-hard rock with the aid of hydraulic motors and cylinders. Unit will drill holes 9 to 12 ft deep and speed of 3 to 10 fpm. This high-pressure drill uses tungsten-carbide tipped, finger or drag rotary detachable bits. Joy Manufacturing Co., Pittsburgh.

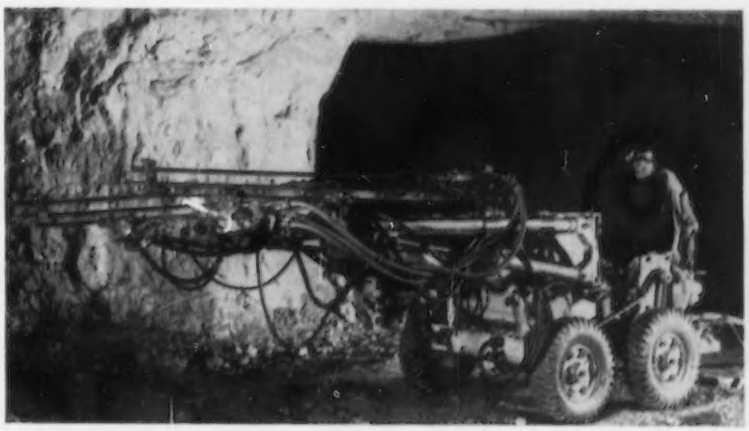
Rotary-percussion drill jumbo, second row left, mounts two Hausherr drills which exert ¾- to 1½-ton screw feed thrust on the steel which delivers 6,000 percussive blows per minute and rotates at 180 or more rpm. B. J. Nykerk Corp., New York.

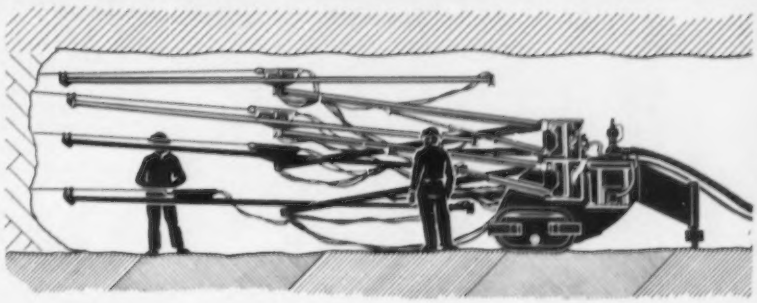
Rotary drill jumbo, second row right, mounts two high-thrust, rotary drills. Floor jacks and roof jacks lock jumbo securely in place. An accumulator maintains jack pressure during drilling. Large cylinders on jib arms maintain an 8,000-lb thrust on the drills. Rogers Iron Works, Joplin, Mo.

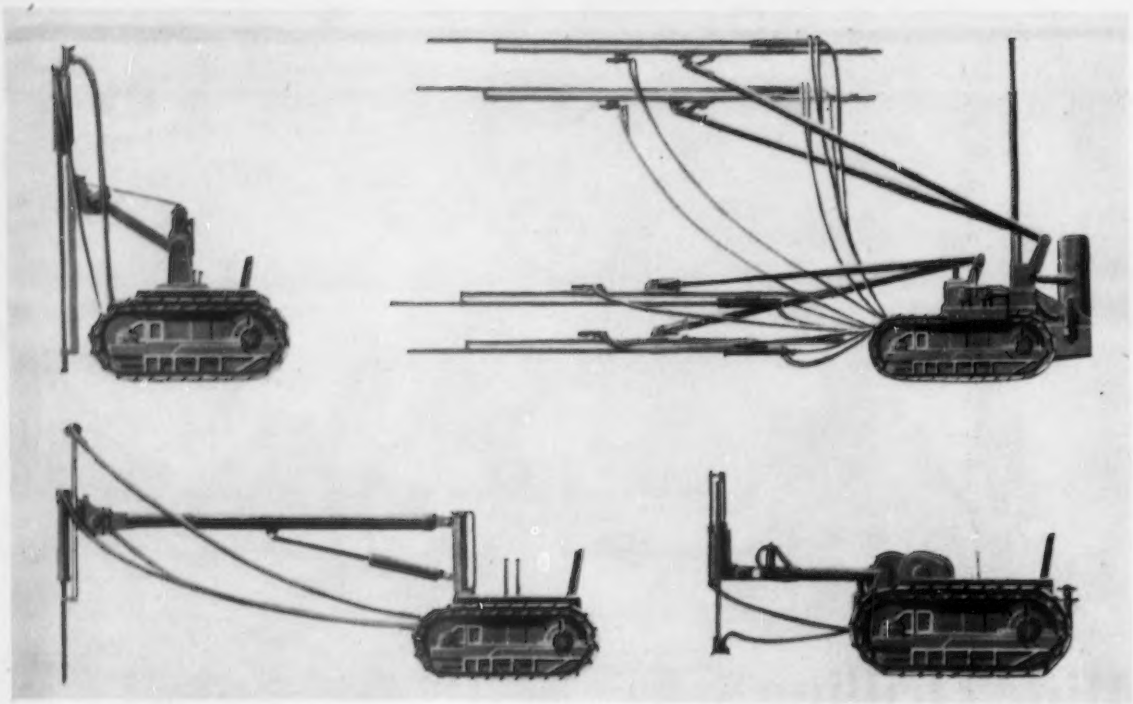
Combination jumbo-loader, third row from top, is fitted with half track to enable the unit to load and drill in the rough ahead of rail ends. Loader feeds ore to conveyor mounted over train. Joy Manufacturing Co., Pittsburgh, Pa.

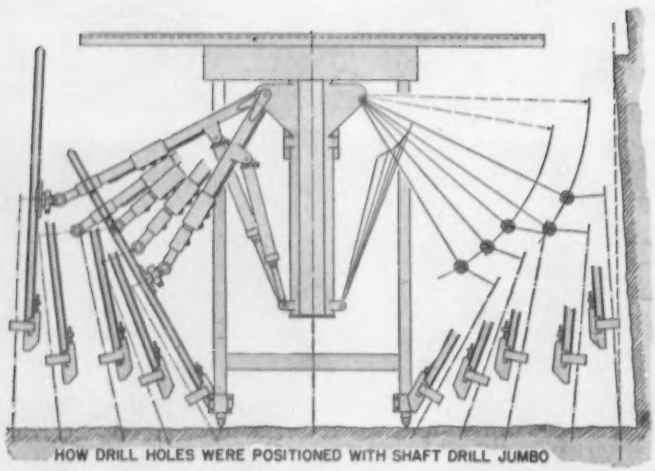
Rubber-tire drill mobile, fourth row from top, is propelled by compressed air to working position. Hydraulically operated jibs position long-sash drills. Joy Manufacturing Co., Pittsburgh, Pa.

Gismo-jumbo, bottom right, is designed to load ore from face, haul it back to train, mount train of cars and load them in sequence—then to drill out a round after face has been mucked out. Sanford-Day Iron Works, Inc., Knoxville, Tenn.

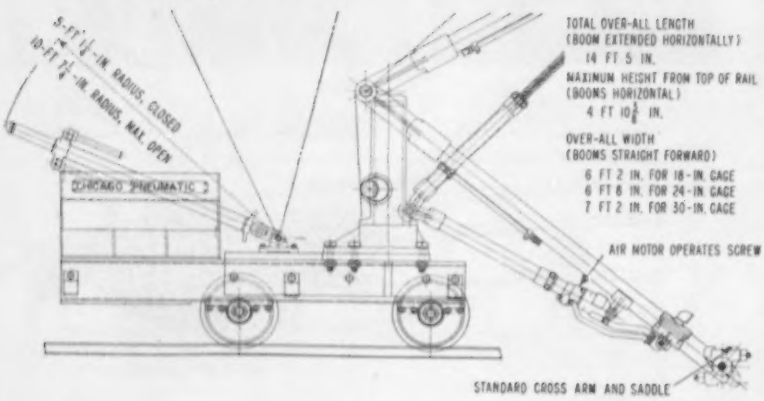








HOW DRILL HOLES WERE POSITIONED WITH SHAFT DRILL JUMBO


5-FT 6-IN. RADIUS, CLOSED
10-FT 7½-IN. RADIUS, MAX. OPEN
CHICAGO PNEUMATIC
TOTAL OVER-ALL LENGTH (BOOM EXTENDED HORIZONTALLY) 14 FT 5 IN.
MAXIMUM HEIGHT FROM TOP OF RAIL (BOOMS HORIZONTAL) 4 FT 10¾ IN.
OVER-ALL WIDTH (BOOMS STRAIGHT FORWARD)
6 FT 2 IN. FOR 18-IN. GAGE
6 FT 8 IN. FOR 24-IN. GAGE
7 FT 2 IN. FOR 30-IN. GAGE
AIR MOTOR OPERATES SCREW
STANDARD CROSS ARM AND SADDLE

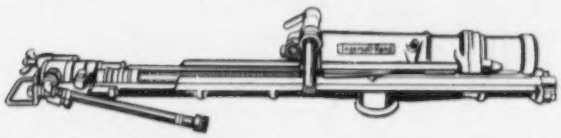
Drill Mounts

The four illustrations above show how versatile a tractor can be for the mounting of various drills, booms and jibs for vertical, horizontal and inclined holes. This unit can be employed for open-pit operations as well as for underground. Illustrations above show that drills, and jibs, by conventional equipment manufacturers can be adapted to the tractor. Tractor illustrations by Eimco Corp., Salt Lake City, Utah.

Shaft drilling can also take advantage of the labor saving features of jumbos. **The unit at left** features precise mechanical positioning of drills so that holes will be drilled round after round in the same manner. C. Kramer Bain designed this model originally. The one shown here is a modification of his design used by McKenzie & Whittle, construction contractors, to sink two 15-ft circular shafts at the National Potash Co. property near Carlsbad, N. M.

An additional track-mounted boom-jumbo **is shown at lower left.** The car is blocked securely to the track with air-operated ceiling jacks. Booms are quickly adjusted to drilling position through vertical adjustment by rotary air actuating motor which has positive locking features to prevent the boom arm from falling or settling. Chicago Pneumatic Tool Co., New York 17.

DRY DRILL uses vacuum to remove cuttings. (Holman, Dryductor)



POWER-FEED drifter for heavy drilling. (Ingersoll-Rand, DB35)

LONG-FEED power drifter. (Joy, T-30 drill on PM48A feed)

MOTOR-FEED heavy drifter. (Chicago-Pneumatic, 60-N)

Progress In Rock Drill Design

A THOROUGH SEARCH of bulletins and literature published by leading rock drill manufacturers reveals great progress in design. Here are some important items:

1. Worker comfort. Great effort is made to relieve today's miner of the old-fashioned grunt-and-groan aspects of drilling. The feed-leg units below are an example. The dry-type dustless drill above and the various motor-fed drifters at left all help eliminate effort. Study also the many jumbos on pp 78-80 which make drilling practically an automatic process.

2. Efficiency. Compressed air is convenient for power, but it is also costly. Drill manufacturers are concentrating on new valve designs to conserve air, also light drills which take advantage of tungsten-carbide's strength.

3. Hole-cleaning ability. Drill, steel and bit designs are being improved to remove cuttings from the hole as speedily as possible. This increases drill efficiency because the tool then becomes a rock cutter rather than a grinder. Rock grinding should be consigned to the ball mill.

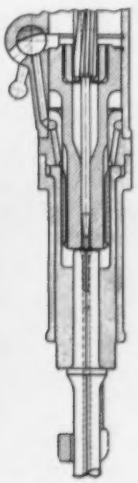
4. Powerful rotation. Drilling efficiency is directly related to the speed of rotation, and to proper selection of up-stroke or down-stroke drills. These two variables alone, mean that an operator may have to choose one out of six or eight possible combinations to select the best method. At this point it is best to consult the field engineers of drilling manufacturers. See buying directory.

5. Rotary designs. Many new rotary models are available for drilling soft and medium rock. Rapid advances in the design of tungsten-carbide rotary bits have brought about this trend. Jumbos have been designed to exert tremendous force on rotary steel and bits.

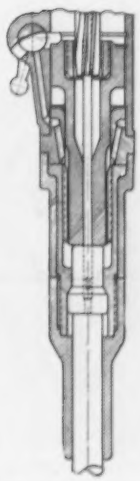
6. Percussion-rotary design. Much interest is now centered on a European model which combines rotary and percussion drilling techniques in one machine. See p 65.

7. Power sources. Small mine operators and prospectors are investigating recent drill models which derive power through a flexible shaft connected to a small gasoline-powered compressor; also types which have small engines built into the drill itself. See p 83.

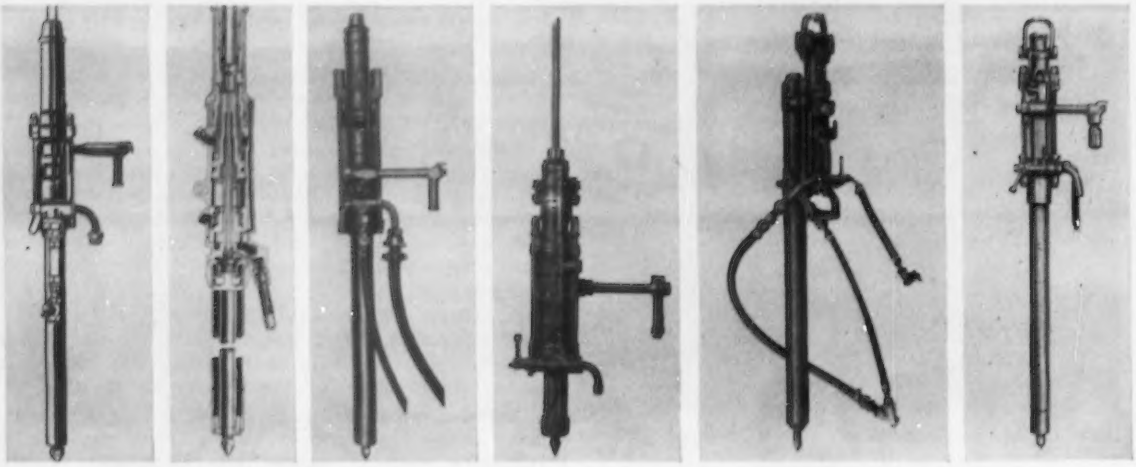
AIR-LEG drill used to install roof bolts, and netting. (LeRoi, AL-92)



ANVIL was added in feed-leg drill to accommodate flat steel. (Atlas-Copco)



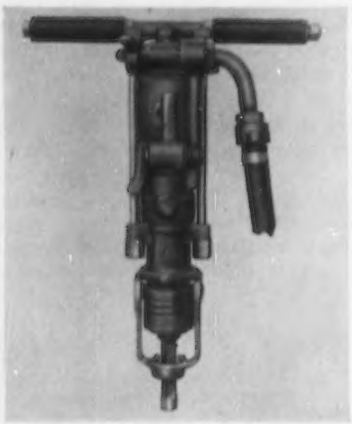
SINKER DRILL installed on air-leg combination. (Chicago-Pneumatic)

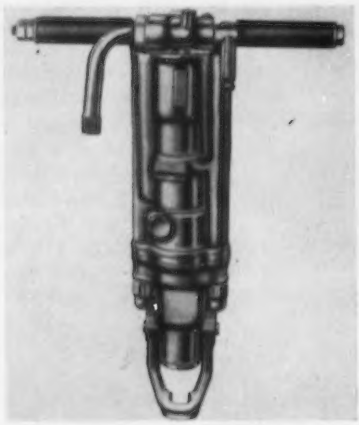


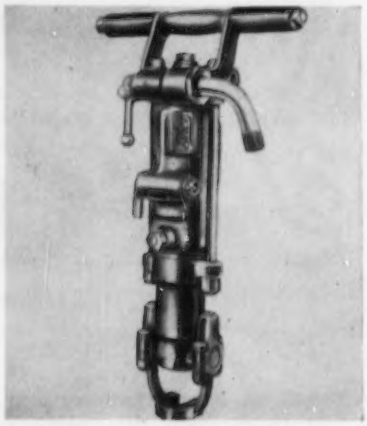
Stopers—Conventional and Special Designs

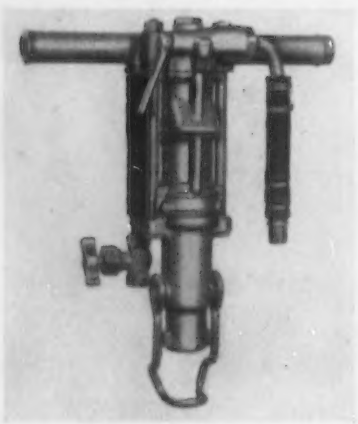
Many models of stopers are available for heavy and light drilling; for short and long holes; for low and high backs; and for special mining problems. The above selection includes the following stoper models left to right:

A conventional stoper, Ingersoll-Rand; cross section of a standard Gardner-Denver model; Chicago-Pneumatic CP-44 stoper; telescopic feed-leg type Joy-Sullivan, SA-91T; raiser-leg type with sinker drill, Thor, 58 leg, and 38 drill; lightweight stoper with 26-in. feed which weighs only 79 lb, Le Roi, S-10.





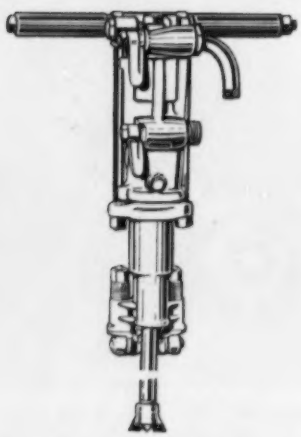


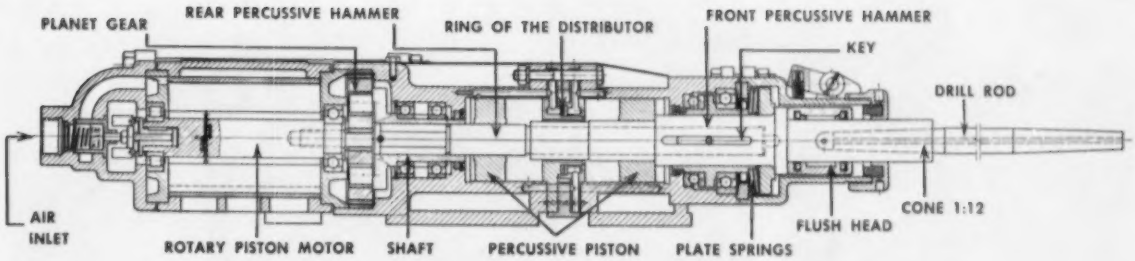


Sinkers and Jackhammers

The above selection of sinkers and jackhammers includes wet and dry types, also light and heavy models. Drills shown here are as follows: Top left, dry-type sinker drill, Chicago Pneumatic, CP-32A; top center, hand-held 55-lb sinker drill, Joy, LB-57; top right, sinker drill, Thor, Model 33; left, sinker rock drill, Le Roi, H-22; right, Jackhamer with Jackrod and Jackbit, Ingersoll-Rand, J-50.

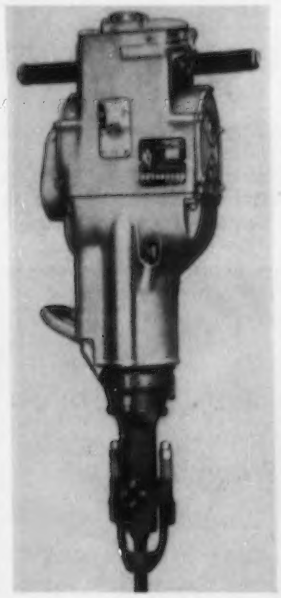
While jackhammers are normally used for down holes, some models are designed to be attached to feed legs or stoper legs so that the drills can be used for holes at any angle.





New Rotary Percussive Rock Drilling Machine

The hard-rock drill shown above is said to give at least 5 times the speed of a 45-lb standard percussive hammer drill. Less bit and steel wear is claimed. Added to the ¾- to 1½-ton screw feed thrust are 6,000 percussive blows per minute and 180 to 200 rpm. Weight of the drill is 255 lb. The drill can use air or water flush, and is made by Hausherr in Germany, and offered by Nykerk Corp., N. Y. (Model Albo DK7ES)



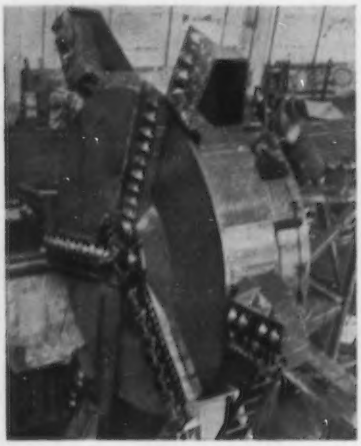
SELF-CONTAINED gasoline-powered rock drill, left. (Syntron)

GASOLINE hammer rock drill, right. (Svenska Motorborr)

SMALL HAND-HELD rotary rock drill for auger steel. (Thor)

GASOLINE-POWERED DRILL operates off of flexible shaft in Chibougamau, Quebec area. (Pinazza P60-S4 set)

ROTARY AUGER DRILL designed primarily for long blast holes, as deep as 100 ft for 2½-in. dia. (Chicago-Pneumatic)



New Ways to Mine Medium and Soft Ground

Softer ores such as potash and phosphate are now mined with devices that eliminate drilling and blasting. The tunnel borer, above left, has six outer cutting elements that rotate opposite to the three inner ones. Action of the borer is similar to that of a huge non-coring diamond bit. The continuous borer at right is maneuvering to make a 90-deg turn. All movements of the machine are hydraulically controlled. Success of this large boring machine is due to the development of hard cutting parts. (Both units by Goodman Mfg. Co.)

CONTINUOUS MINERS such as this are now being used in potash mining. (Joy Mfg. Co.)

PROTOTYPE of phosphate planer developed by U. S. Bureau of Mines and F. E. Burnett of Anderson mine, Montana.

SYNCHRONIZED ROTATION of cutting elements accounts for the success of this continuous mining machine designed for the coal mining industry. It is adaptable to mining of soft ores. (Jeffrey Colmol)

From Bit to Shank, Many Tools Make Holes

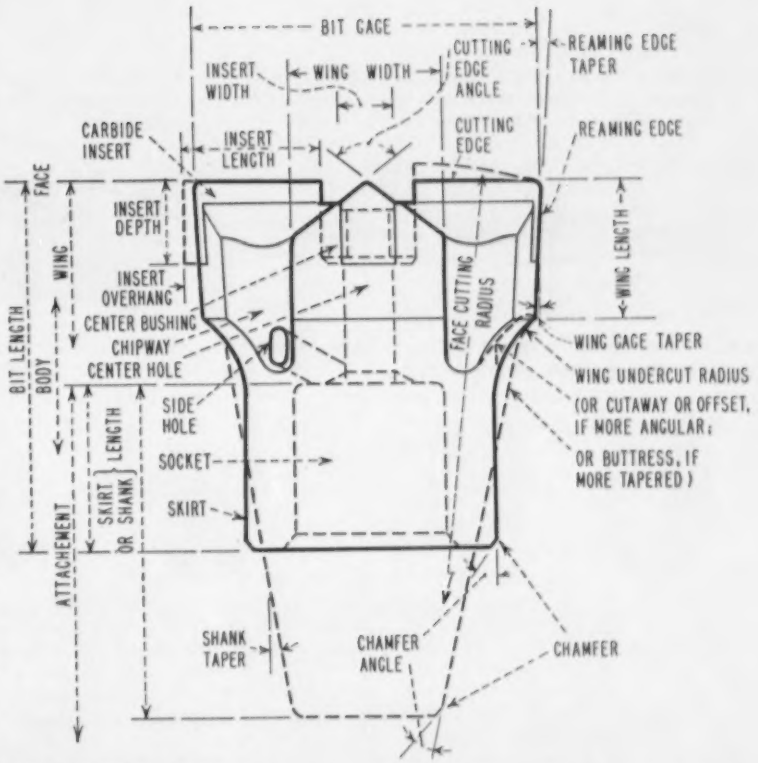
MAKING A HOLE IN ROCK, as in any material, requires two basic steps: breaking bonds within the mass and removing the resulting smaller units. The smaller units could conceivably get down to sub-atomic particles. But present rock drilling methods involve considerably larger units. Even so, there are many ways in which the bonds may be broken. For example: by chemical, thermal or sonic action, or by explosive or hydraulic as well as mechanical forces.

Recent research into fundamentals of penetrating rock indicates that, at least for making large-diameter long holes such as oil wells, mechanical force is the most economic means. Thermal devices—jet piercers—are being used in taconite open pits, but for underground drilling, mechanical force is used exclusively.

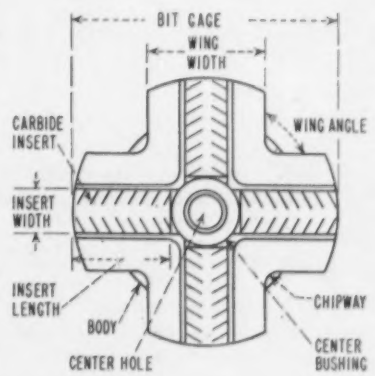
Mechanical force is applied to the rock in essentially two ways: "percussive" which breaks the rock bonds by sudden compression; and "rotary" which breaks them by shear. In practice, both also produce a tensile stress in the rock by wedging action along surfaces of weakness. Only recently have the two basic actions been combined in a single underground machine. But for some time, on surface, the large roller-cone bit has been producing such action using rotation.

Again there are many possible ways to develop the mechanical energy and produce the desired force. Current underground powering devices are shown in the preceding section. This section deals only with means of transmitting to the rock the action developed in those machines. Open pit and exploratory drilling are covered in still other sections. Since there are so many facets to drill bits and steel, the reader is urged to consult the numerous articles and recent books for greater detail.

Rock itself is the first factor to consider in any mining plan and most especially in selecting the components for drilling. Its so called "hardness" is probably the most important quality. As a general physical property of homogeneous substances, "hardness" is only vaguely defined, although there apparently is an underlying concept of resistance to penetration (i.e., breaking bonds). For instance, in minerology, it is measured by scratching (abrasion); in physical metallurgy, usually by indentation (plastic deformation). Brittleness, a property related to hardness, concerns failure with little deformation. Harder materials are generally more brittle.



BIT NOMENCLATURE lacks standardization. Various catalogs, magazine articles and Government publications have been used to prepare terms used above and below. With some additions (see page 88) they can be used for rotary bits.



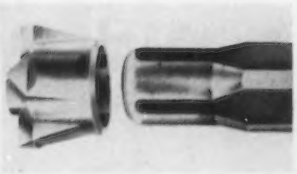
In drilling heterogeneous rock, many additional physical characteristics are involved: inclusions, fractures, strength of cementation, grain size, compaction, et al. As an all inclusive term, "drillability" is used to compare rocks. It is the ratio of rate of penetration in any rock to the rate in a standard rock, using standard drilling apparatus and operating conditions.

One guiding concept stands out for all drilling—in removing any given volume of rock, the larger the *final* cuttings, the lower the energy consumed.

Percussive Tools Crush Hard Rock

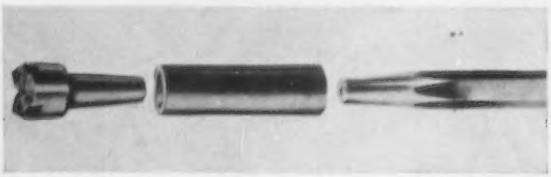
In percussive drilling tools, surprisingly enough, a tensile stress is a major concern. The blow which the machine sends down the tools is a sound wave—composed of compression and tension elements. Compression has been resisted without much difficulty but not so the tension. And even though it is in direct contact with the rock face, the cutting edge of the bit is subject to this damaging tension too. Though this factor can-

Integral Bit and steel obviates attachment problem. Bendable steel goes to 33 ft. Needs more rigid starter. (Atlas Copco)

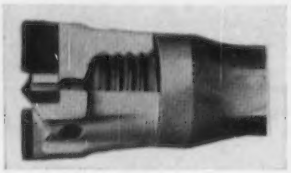


Detachable, Single-use, minimizes handling. (West. Rk. Bit)

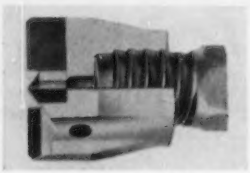
Multi-use, threaded, has hard inserts. (Atlas Copco)



Male Slip-on eliminates thread problem and is handle when resharpening. Coupling centers bit. (Can. Ingersoll-Rand)



Female shoulder drive get blow through skirt. (Ingersoll-Rand)

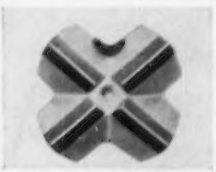


Bottom drive gets blow on socket bottom. (Brun. & Lay)

Short body has deep chipways to pass cuttings easily. (Joy)

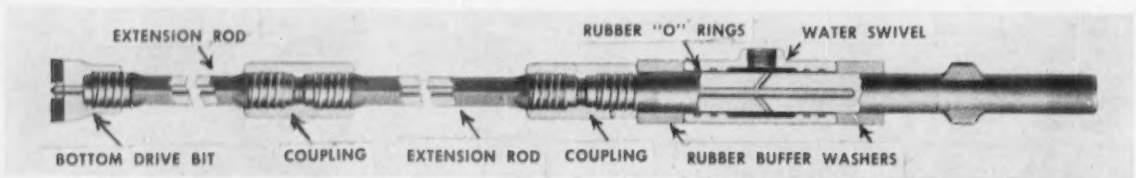
Long body with buttress, extracts smoothly. (Vascoloy-Ramet)

Cutaway wing with little drag can aid extraction too. (Timken)

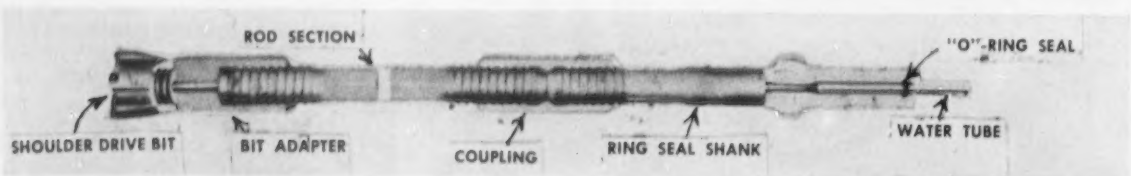


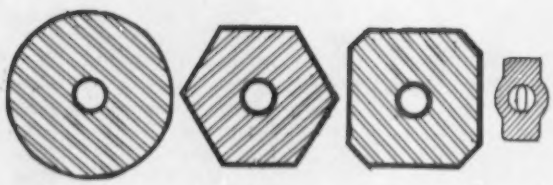
X style is designed to stop rifling in hole. (Brunner & Lay)

Six point steel lends itself to single-use in soft rock. (Timken)



Longhole drilling uses special rod section at machine to get better seal of additional wash water needed. In coupling, rods butt together but ridge (semi-bridge) at center prevents thread overrun. Bit end is treated special too. (above, I-R; below, G-D)





Cross-section of rods in common use are (left to right): round, hexagon, or quarter octagon. (Gardner-Denver) On right is section through shank of flat steel shown at top of page.

Plain shank (left) is used with tappet machine, e.g. stoper; **collared** shank (center), where machine extracts rod; and **lugged** (right) for rotation and extraction of round rod (G-D)

not be considered further here, it is worthy of mention since it seems to be omitted in many discussions on bits and steel.

The percussive bit applies the sudden compression (impact) to the rock, shattering it to some depth and fracturing it below. Then the bit rebounds from the rock surface and is moved some distance away (rotated, i.e. indexed) before the next blow. At the same time, water or air conveys the particles away. Many features of indexing as well as of other effects of the bit action, deserve the attention of those interested in penetrating rock. But they cannot be suitably covered here.

The cutting edge, as in any cutting tool, concentrates the energy of the blow into a small area—the smaller the area the deeper the penetration. But for strength and wear resistance, it must have adequate cross-section. The cutting edge angle limits the depth of penetration. With the blow used in conventional machines, penetration can be deeper in soft rock than in hard. In slate, a 70-deg angle on a steel bit has been effective. On the other hand, in hard rock (basalt) strength and wear of cutting edge is more important and a 120-deg angle on a tungsten carbide insert bit is suggested. Because of the weakness of inserts, 90 deg is about the minimum for them.

For face cutting radius (see nomenclature drawing) authorities recommend a short radius (2 in.) for hardest rock and an infinite (flat) one for very soft rock. But on a multi-wing bit, re-sharpening is an obstacle to anything but a flat edge.

Reaming edges come in for considerable abrasion both during the linear movement and the rotation. A wider wing or insert width is needed to resist the most abrasive rocks and to reduce rifling. To reduce drag, a taper of about 0 to 5 deg is used. Inserts will wedge and crack if anti-taper develops.

Inserts of "hard metal" consist of minute grains of a highly abrasive-resistant compound (usually tungsten carbide, i.e. WC) cemented together by a matrix of tough metal (usually cobalt). Resulting over-all "scratchability" hardness of the "tungsten carbide" (TC) insert is about equal to topaz (8 Mohs) or about 90 Rockwell A (75 Rc) indentation hardness. Percussion bit inserts have about 10% Co. Good support and bonding (brazing) in bit, is important.

Cuttings removal is another critical bit design feature. Larger exit spaces and more flow are ways to speed it.

The bit attachment to the drill rod is given much attention (see illustrations). Some slip-on detachable bits use a camming action of grooves, flats or spiral. Others use differential taper or diameter between bit and rod. Actually all hold by friction.

Other detachable bits use a thread. Though not designed to transmit the blow, threads cause stress concentrations and two failures must be combatted: thread strippage and skirt (or rod) breakage.

Two cross-sections are in general use for threads on the female bit: a semi-circular "lamp socket" and an angular "rip-saw." The first is used on shoulder drive bits the other on bottom drive. A third "rope-like" thread is used on a male detachable bit. Thread designation within a given style is based on diameter. Some makers use letters; other, numbers. Different manufacturers' threads are not identical though most can fit the others'. Efforts are being made to standardize the thread contour such as has been done for diamond drilling tools. But there is opposition since each factor has some advantage.

Only a few of the innumerable factors entering into the selection of bits have been presented. Some others are hinted at in the illustration captions. But many others remain—reconditioning for instance. Single-use slip-on bits can completely eliminate the need for a blacksmith shop. But the loss of gage on such a bit in hard rock was a problem. The introduction in the last few months of a TC insert slip-on single-use (Thompson Products) may give a solution. On-the-other-hand, some mines find lowest cost in making their own TC integral bits, which require even more shop-work than forging and sharpening.

Drill Steel Problem is Being Solved

The percussive drill rod transmits the blow and rotation of the machine to the bit. The rotative force is low and is of little concern. The column effect is also of limited concern because the rock offers support. The tensile strength, or more precisely the fatigue strength, is by far the most critical factor.

Briefly, fatigue failure is caused by progressive extension of minute cracks. The cracks form along slip planes when stress exceeds elastic and plastic limits and the poly-crystalline material shears. Geometric or metallurgical "notches" cause stress concentrations which promote the action as does water. The latter effect is not simply due to corrosion pitting and cracking. There is also a phenomenon of liquid action on any poly-crystalline substance under strain, which lowers the strength. In addition, water (or liquid) permits an electrolytic action to take place between areas of the steel itself at stress concentrations.

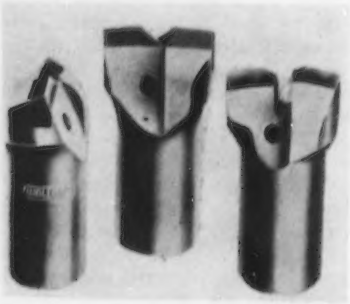
Steel composition at first was aimed at simply giving a material which could withstand abuse and be suitably forged and sharpened to desired shape and heat treated for hardness. Plain carbon steel works well. But as the gage-maintaining qualities of TC bits made smaller holes more feasible, steel of smaller diameter was needed. For equal life, greater strength was needed and alloy steels became popular. Long hole drilling with larger more powerful machines, accentuated the demand for stronger and longer-lived steels.

For one thing, the metallurgical notch—an area of low strength—became apparent. It can partially be solved by "overlapping" the heating to cause surface and interior to have notches at different points along the rod. It can be completely solved only by heat treating the entire rod.

Geometric notches from abuse and at attachment and shank, give weaknesses. A number of designs directed to smoothing them out have been developed, e.g. pear-shaped collars on shanks, slip-on attachments, etc.

Alloy steels are designed to give higher "as rolled" hardness but heat treatments are more difficult and can defeat the advantage. As a result, there is a move toward use of prefabricated rods with no local preparation or reconditioning—at least no heat treatment. It pays. Alloys can be grouped into four types: low (under 0.3%) or high (about 1%) carbon, high chromium (0.8-2.5%), molybdenum (0.2-0.35%); and low or medium (under 0.5%) carbon, nickel (1.5-3%)-chrome (0.4-1.2%)-moly. All have manganese too.

Surface treatment can be said to be designed to increase the surface hardness which prevents development of cracks. Mechanical treatment consists of placing the surface under compression by shot-peening or rolling. Metallurgical hardening treatments used involve either adding carbon or heat-treating only the surfaces by electrical induction, et al.



Bits are female slip-on. Deep slot is for soft rock. Rod ends are male conical.

Rotary Tools Scrape Soft Rock

A rotary drilling action shears off particles from the rock mass. Two force vectors act: a linear thrust and a rotary (tangential) force perpendicular to the thrust. The thrust must cause the cutting edge to penetrate the rock by compression failure. And once a small face is produced, the rotary force can come into play. While the resultant of the two forces acts into the rock, for the chip to form, the shear surface must break out to the free face (bottom of the hole). Once a chip shears off, the cutting edge is subject to abrasion as it passes to the next free face and subject to impact when it strikes the next face.

Bit design must balance angles that permit rapid penetration with angles that give adequate strength and support to the cutting edge. As in percussion drilling the cutting edge angle will penetrate faster if sharper, but for strength it must be wider, especially in harder rock. The end rake of the leading face of the cutting edge has an influence since the rotary force acts perpendicular to this face. Microphotographs indicate that the shear surface produced by a negative rake causes a flatter angle with the free face than a positive rake. This makes a larger chip. But authorities say in harder rock a positive end rake will give faster penetration rate with a given thrust and rotation; on the other hand, a negative end rake gives better support to the cutting edge if end relief angle remains the same.

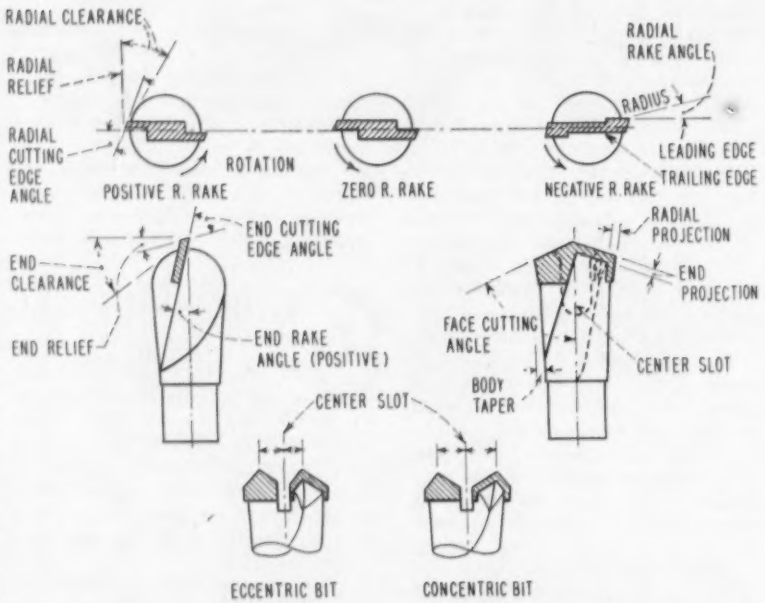
Cutting edge angle is also influenced by end relief and clearance angles. For the path of the cutting edge is a helical surface and the clearance angle must be enough so that full thrust load bears on the cutting edge and friction is minimized. Since the portion of the bit nearest the axis of rotation travels a steeper path, the relief and clearance angles should be greatest at the axis. But since clearance

Rotary-Percussive Tools Combine Two Designs

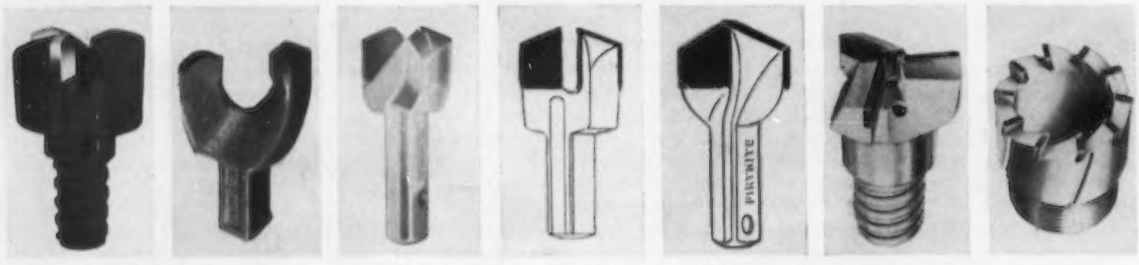
Though still in infancy, the method of using both the intermittent impact of the percussive bit and the steady scrape of the rotary has given some record penetration rates at moderate costs in hard sedimentary rock. So far, results in hard igneous rocks have not been publicized.

Thrusts required and bit wear produced with rotary tools in hard rocks make such drilling uneconomical. And, while costs are low with percussive apparatus, penetration rates are low too. On the other hand, while giving superior results, one rotary-percussive unit tested is reported to have used somewhat more air.

The tools must transmit and withstand the dual action. Bits have inserts. Round rod has conical shank.

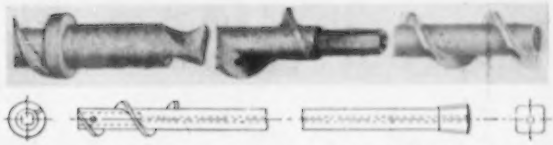


ALL BITS can be given same basic nomenclature (see page 85) but rotary types have more elements to consider. Slot elements can be described in similar terminology.



1. Vascoloy-Ramet *2. Allegheny Ludlum* *3. Kennametal* *4. Carboloy* *5. Firth Sterling* *6. Kennametal* *7. Kennametal*

1. Three prong often has spade (roof) type pilot added. **2. Two prong,** wide slot for soft rock, passes chips easily. **3. Roof** bit has small V-slot for medium hard rock. **4. Groove** in shank is for cooling, wash or wetting water. **5. Solid** insert is best in variable and harder rock. **6. Drag** bit has wide inserts for long wear. **7. Core** bit also aids diamond drilling.



Finger bit is for large holes (above, Salem Tool). Auger rod, hollow in larger sizes, are commonly used with twisted or snap-button shanks. Threads on extension rod fit male coupling. Square shank is on special roof bolt rod with short scroll.

angle at the axis is usually too small, considerable thrust absorption and grinding takes place. Even a small notch or gap at the axis gives high increase in penetration rate.

On the reaming edge radial rake enters the picture and also plays a part in support of the cutting edge. A negative radial rake permits greater support to the edges and is recommended by some for harder rock.

Bit shanks are of many designs (see illustrations). Most have angular cross-section somewhere along the length to transmit rotation. Frequently a rivet and hole is used to fasten the bit onto rod. Others use groove and key of some sort. Some shanks have hollow center for introduction of wash water close to face; others use groove. Since inserts are brittle, rigid attachment for bit is best.

Rods are auger type mostly, probably because wash water is not widely used to convey cuttings. Even though the scroll reduces cross-section of stem and gives lower torsional strength, apparently the rotative forces used are insufficient to make it critical. Scrolls are usually welded.

Diamond Tools Gouge Holes in Any Rock

In diamond drilling, as the bit rotates the diamonds which protrude the most, gouge small grooves. The other "stones" gouge as well as fracture the remaining ridges. Properly matched pressure (i.e. feed) and rotation must make the stones constantly advance and penetrate the rock. Otherwise they "polish" flat and become useless. And, of course, it is important that the material carrying the chips away, flow rapidly enough to prevent fine and/or soft material from caking between diamonds.

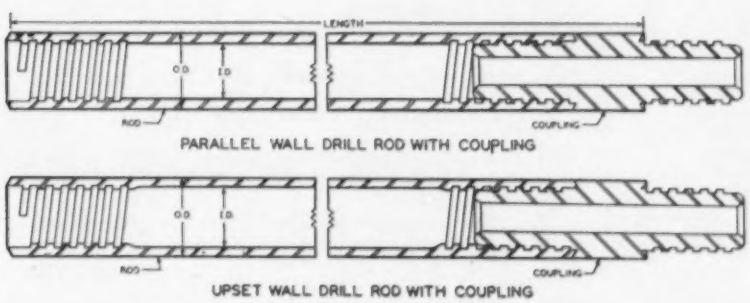
The bit consists of three parts: the body ("blank") usually of low carbon steel; the matrix; and the diamonds. The matrix joins the diamonds to the blank and supports them. It can be made from various metal alloys designed to give desired wear. When making bit, temperature must stay low enough to avoid damage to diamonds. Sintering powered metal, permits using cemented hard metal alloys with high melting points.

The most common bit diamond is called bortz—hard diamond grains, not suitable for gems, made up of small rather regularly arranged crystals. Best quality have no internal flaws and are roundest, (i.e. dodecahedrons).

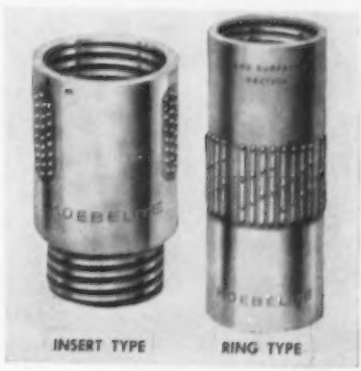
In inexpensive impregnated bits (usually coring, especially for broken or very fine grained very hard rock) small stones and fragments are mixed through matrix. Stones are not salvaged. In set bit, stones are on surface only. Oriented, as against random-set, bits present stone's hardest vector toward rock, but "round" stones are difficult to set in any other manner.

Non-coring bits make blastholes: concave for softer rock. (Wheel Trucing); and pilot (Longyear) or taper) (Sprague & Henwood) for harder. Hard matrix and small stones fit hard rock.

Coring bits, used for exploration but also needed in hardest rock, use face shapes to fit rock—combining round (J. K. Smit) and flat (Diamond Prod.). Waterways vary too. (Christensen)



Rods, couplings and fittings are standardized. Core barrels and accessories are not. Rods, of seamless steel tubing, nest. Threads keep straight contours but dimensions and angles change with series. Substitutes are special fittings. (Longyear)



Reaming shells are used behind bit to keep gage and to ream for casing. Ring type finds use in broken ground. (Koebel)

Explosives and Their Applications

WHEN SELECTING EXPLOSIVES, here are the factors to consider:

1. Strength of powder. Percentage of nitroglycerin in dynamite is a measure of the propulsive effect, and ability to do work.

2. Velocity. Speed of detonation ranges from about 1,500 fps to 25,000 fps. High velocities represent greater shattering effect.

3. Fumes. For open work, high fume formation is not important. For underground work this factor must be considered carefully.

4. Density. For dynamites this is expressed in number of 1¼x8-in. cartridges contained in a 50-lb case. Variation in density permits the blaster to concentrate or distribute charges.

5. Water resistance. Explosives vary widely in this respect.

Maker and Type	Strength	Where Best Used	No. of 1¼ x 8-in. Ctgs. per 50-lb Case
AMERICAN CYANAMID CO.			
Nitroglycerin dynamite	20 to 60%	Ditching by propagation. Submarine work. High water resistance.	103 to 108
Ammonia dynamite	20 to 60%	Quarrying. Construction. Medium water resistance.	100 to 107
Amex	80% to 100% blasting gelatin	Quarrying. Construction. Mining other than coal. Fair water resistance. Fumes: good.	120 to 170
Straight gelatin	20 to 100%	Quarrying. Oil and gas wells. High water resistance. Fumes: very poor.	89 to 100
Standard gelatin	30 to 90%	Quarrying and open pit operations. General underground mining, including shaft and tunnel work. Excellent water resistance. Fumes: good.	91 to 99
Semi gelatin	80% to 100% blasting gelatin	Quarrying and open pit operations. General underground mining, including shaft and tunnel work. Good water resistance. Fumes: good.	110 to 137
Cyamon blasting agent	40-50-60%	Quarrying. Stripping. Construction. Insensitive to caps or Primacord. Non-headache producing.	Sticks not less than 3-in. dia.
Cyamite blasting agent	65%	Quarrying. Stripping. Construction. Insensitive to caps or Primacord. Non-headache producing.	Sticks not less than 4½-in. dia.
Cya-Gel-Pak	40%	Mud capping. Chute blasting. Construction. Packed in Polyethylene bag. Can be formed into any shape.	Bag packed.
APACHE POWDER CO.			
Nitroglycerin dynamite	15 to 60%	Ditching. Work requiring high shattering effect. Water resistance poor to good. Fumes: fair to poor.	104 to 110
Standard dynamite	15 to 60%	Open or underground work under dry conditions. Water resistance fair. Fumes: good.	108 to 110
Special dynamite	20 to 55%	Open or underground work under dry conditions. Mining soft materials. Water resistance fair to poor. Fumes: good.	172 to 115
Gelatin	25 to 100%	Open or underground work where great water resistance is necessary or in extremely hard rock. Water resistance very good. Fumes: good in 25 to 60% class. Poor in 75 to 100% class.	87 to 106
Special gelatin	30 to 90%	Open or underground work under severe water conditions or in hard rock. Water resistance very good. Fumes: good in 30 to 80% class. Fair in 90% class.	90 to 106
Amogel	30 to 60%	General open or underground work where moderate water conditions prevail. Water resistance good. Fumes: good.	140 to 110
Quarry dynamite	5 to 70%	Open dry work in large holes where bulk-packed, free-flowing dynamite can be used, such as in open pit mining. Water resistance poor. Fumes: poor.	Bag packed.
Carbanite blasting agent	70%	Open work in dry holes 5-in. plus, such as open pit mining for relatively soft material. Requires high explosive primer. Water resistance poor. Fumes: poor.	Bulk packed.

Explosives and Their Applications *(Continued)*

Maker and Type	Strength	Where Best Used	No. of 1¼ x 8-in. Ctgs. per 50-lb Case
ATLAS POWDER CO.			
Nitroglycerin dynamite	20 to 60%	Ditch blasting and other open work. Water resistance fair. Fumes: fair to poor.	105 to 115
Extra dynamite	15 to 60%	May be used underground where ventilation is good. Limited water resistance. Fumes: fair.	105 to 115
Blasting gelatin	100%	For very hard rock and under high heads of water. Very good water resistance. Fumes: fair to poor.	100 to 110
Gelatin	20 to 100%	For extreme wet work and hard, tight shooting. Very good water resistance. Fumes: good to poor.	85 to 110
Giant gelatin	30 to 90%	Used underground where ventilation is good. Very good water resistance. Fumes: good to poor.	85 to 110
Gelodyn	65%	General underground work. High cartridge count offers attractive economies. Good water resistance. Fumes: good.	110 to 125
Amodyns	65%	Stoping and tunneling. Slab and angle blasting in limestone mines. Limited water resistance. Fumes: good to fair.	118 to 182
Apcodyn	65%	Pre-waxed shells used underground and re-dipped shells for surface work. Limited water resistance. Fumes: good to fair.	128 to 153
Apex	20 to 70%	A quarry and stripping explosive. Good water resistance. Fumes: poor.	Large ctgs.
Flo-Dyn, Canyon Bag	10 to 65%	For vertical drill holes in quarry and open pit and Coyote tunnel work. Limited water resistance. Fumes: fair to poor.	Bag packed.
E. I. DU PONT			
Straight dynamite	15 to 60%	Ditch blasting by propagation. Water resistance poor in lower strengths. Very good in 60% class.	102 to 106
"Red Cross Extra" dynamite	20 to 60%	Quarry and open pit operations where material is of medium hardness. Good water resistance. Fumes: fair.	110
DuPont "Extra" dynamite	A to H (High velocity series) A-1 to G-1 (Low velocity series)	Both products used for soft ores and non-metallic minerals. Grades A, B, C, D, E, A-1 and B-1 have good water resistance. Other grades poor. Fumes: good to fair.	115 to 172
"Red Cross" blasting FR Dynamite	25 to 65%	Coyote tunnel blasting and loading small holes, either sprung or not sprung. Water resistance very poor. Fumes: very poor.	Bag packed.
DuPont gelatin	20 to 90%	General underground work and open pit mining. Water resistance very good. Fumes: good in the 20 to 60% grades. Very poor in higher grades.	85 to 107
Blasting gelatin	100%	Special cases of tunnel driving, shaft sinking. Waterproof. Fumes: poor.	83
"High Velocity" gelatin	40 to 90%	General underground work and quarry and open pit operations. Water resistance very good. Fumes: very poor in 70 to 90% grades. Very good in lower grades.	94 to 120
Special gelatin	30 to 90%	Underground work and quarry and open pit operations. Water resistance very good. Fumes: very good in 30 to 80% grade. Fair in 90% grade.	89 to 109
Gelex	No. 1 to 5	Underground work and quarry and open pit operations. Have replaced gelatin of about same bulk strength. Give lower costs than gelatin dynamites when applicable. Water resistance very good to good. Fumes: very good.	110 to 150
"Nitramon" blasting agent	A, B, and No. 2	Quarrying, stripping and open pit operations. Coyote tunnel blasting. Water resistance unlimited. Non-headache producing.	Packed in sealed metal containers.
"Nitramex" blasting agent	No. 2	Breaking hard formations where high bottom is often left in primary blast. Water resistance unlimited. Non-headache producing.	Packed in sealed metal containers.

Explosives and Their Applications *(Continued)*

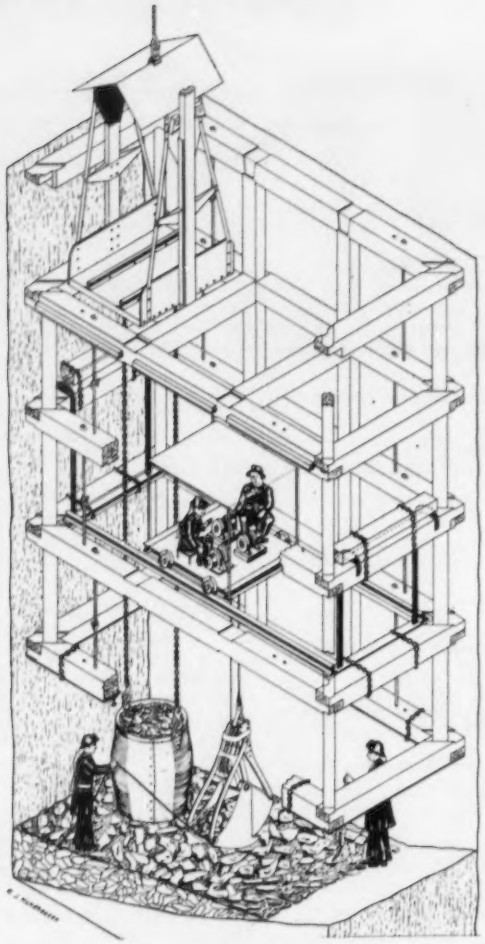
Maker and Type	Strength	Where Best Used	No. of 1¼ x 8-in. Ctgs. per 50-lb Case
"Nitramite" blasting agent.	.....	Excellent blasting action in both hard and soft materials and either vertical or horizontal holes. Good water resistance. Non-headache producing	Sealed containers.
Akremite blasting agent*...	.....	Overburden and wide variety of bank shooting. Dry holes. Packing moisture resistant. Non-headache producing.	Bag packed.
*Licensed exclusively to DuPont under Maumee Colleries Co. Process Patent No. 2,703,528. Sublicensed to other companies.			
HERCULES POWDER CO.			
Nitroglycerin dynamite....	25 to 60%	Ditch blasting by propagation. Mudcapping. Water resistance good in higher grades. Fumes: very poor.	104 to 110
Extra dynamite.....	40 to 60%	Quarry and open pit mining. Clay blasting. Water resistance good. Fumes: poor.	108 to 110
Hercomite® 2 to 7 inclusive	65%	Underground mining and quarry operations. Water resistance fair. Fumes: fair.	120 to 175
Gelatin extra.....	30 to 90%	General underground work. Quarry and open pit mining. Water resistance very good. Fumes: good.	90 to 106
Gelamite 1, 2 and 3.....	65%	General underground work and quarry and open pit mining. More water resistant than Hercomite. Fumes: very good.	112 to 132
Herculite bag powders.....	22 to 60%	Quarry and open pit mining. Water resistance very poor. Fumes: poor.	Large cartridge or 23G containers.
Hercomite bag.....	65%	Quarry and open pit mining where powerful, yet slow, heaving action is desired. Water resistance very poor. Fumes: poor.	Bag packed.
Hercomite bag-X.....	65%	Quarrying, especially in quarry tunnel blasting. Water resistance very poor. Fumes: poor.	Bag packed.
ILLINOIS POWDER MFG. CO.			
Nitroglycerin dynamite....	15 to 60%	Ditching by propagation. Mudcapping. Water resistance good in higher grades. Fumes: very poor.	100 to 110
Ammonia dynamite.....	15 to 60%	Quarry work, secondary shooting, clay mining, and ditching. Less water resistance than nitroglycerin. Fumes: poor.	104 to 110
Nitroglycerin gelatin.....	20 to 100%	Submarine and demolition work. Road construction, etc. Water resistance excellent. Fumes: poor.	85 to 105
Ammonia gelatin.....	20 to 80%	Underground quarrying and mining operations. Work in hard rock. Tunnel driving. Water resistance good. Fumes: good.	90 to 108
Semi-gelatin.....	6 Ajax series 60 to 65%	Underground metal mining and quarrying to tunnel driving where medium loading density and moderate water resistance is required. Fumes: good.	105 to 133
Powertools.....	B, C, D, E, F and G 65%	Blasting moderately hard rock. Underground operations such as salt, iron, clay, sand, bauxite mining. Quarrying and construction work.	120 to 175
	H 65%	For blasting softer rock.	220
	4 and 5 65%	For soft, stratified rock or consolidated soil. All Powertols have fair water resistance. Fumes: good.	142 to 153
Bag powders.....	10 to 65%	Open pit, stripping, and quarry operations. Water resistance and fumes very poor.	Bag packed.
NATIONAL POWDER CO.			
Nitroglycerin dynamite....	20 to 60%	Ditching by propagation where an extremely fast, highly shattering explosive is required. Water resistance fair. Fumes: fair to poor.	105 to 115
Standard ammonia dynamite.....	15 to 60%	Quarry and construction work. Tunnels. Nonmetallic mines. Water resistance limited. Fumes: fair.	105 to 115
Hi-Power ammonia dynamite.....	65%	Strip mines and quarries where a slow heaving dynamite is required. Water resistance limited. Fumes: good to fair.	118 to 182, but manufactured in 4-in. or larger cartridges.

Explosives and Their Applications *(Continued)*

Maker and Type	Strength	Where Best Used	No. of 1¼ x 8-in. Ctgs. per 50-lb Case
NATIONAL POWDER CO. *(Continued)*			
Dolomites	65%	Non-metallic mines and underground quarries. Rock work and tunnels. Water resistance fair. Fumes: good to fair.	128 to 153
Blasting gelatin	100%	Demolition work. Well shooting. Water resistance excellent. Fumes: fair to poor.	100 to 110
Straight nitroglycerin gelatin	20 to 100%	Demolition work. Well shooting. Submarine work. Water resistance very good. Fumes: good to poor.	85 to 100
Standard ammonia gelatin	30 to 90%	Quarries. Tunnels. Metal mines. Water resistance very good. Fumes: good to poor.	85 to 110
Tungites (semi-gelatins)	65%	Interchangeable with straight and standard type gelatins where less water is encountered. Tunnel work of all types. Water resistance good. Fumes: good.	110 to 125
OLIN-MATHIESON CHEMICAL CORP.			
Free flowing dynamite	20 to 65%	Poor water resistance. Poor fume classification. Has heavy heaving action rather than shattering action.	135 to 146
Mine-Gel (semi gelatin)	65%	Good to fair water resistance. Very good fume classification. Good ventilation needed underground. Economical for quarrying and open pit work.	100 to 150
Nitroglycerin dynamite	15 to 60%	Powerful quick-acting high explosive. Not recommended for underground work. Water resistance is fair.	
N. G. gelatin dynamite	20 to 100%	Extremely water resistant. Low fume formation. Good for underground. Strongest commercial dynamite.	102 to 106
Super dynamite, Series 1 and 2	65%	Poor water resistance. Wide range in sticks count; gives them high or low velocity as required. Very good fume classification. Used for soft ore.	115 to 170
Super dynamite, Series 3 and 4	65%	Fair water resistance. Same as above.	115 to 170
Special ammonia gelatin	30 to 90%	Excellent water resistance. Excellent fume classification. Grades of 30 to 70% good for underground. Also recommended for open-pit work.	92 to 100
Special (ammonia) dynamite	15 to 60%	More economical grade than nitroglycerin dynamites. As a class do not have good water resistance. May be used underground where ventilation is adequate. Well adapted to open-pit mining.	106 to 108
TROJAN POWDER CO.			
"Standard" explosives	20 to 70%	Open pit and underground work. Excellent for mudcapping in secondary blasting. Water resistance good. Fumes: very good.	109 to 120
"C" explosives	30C, 40C, 50C, 60C, and 70C	General blasting in open pit or underground workings, especially where heaving and stressing action is required. Water resistance fair, improving as strengths increase. Fumes: very good.	116 to 122
Low density explosives	Medium to low velocity varying with density. All grades have excellent gas volumes.	Economical and effective explosives for softer rock or where good heaving rather than great shattering effect is required. Underground mining of non-metallic minerals and open pit strip mining. For upper charges in deep, large-diameter holes and for secondary block-hole work. Water resistance fair. Fumes: very good.	
TL 509			130
TL 502			135
TL 503			145
Trojatol No. 2		Not recommended for underground use.	155
Trojamite 2 to 7			125 to 169
Bag powders	10 and 20% CC Bag 25 to 60% C Bag 60% C Special Bag Trojamite Bag	Quarry, highway, and construction work. Coyote tunnels. Sprung sinker or wagon drill holes and ragged large diameter holes.	Bag packed.

Mucker for Inclines and Vertical Shafts

The Cryderman Mucker shown above was developed in Ontario to introduce positive action in shaft mucking. Positive action is achieved through effortless finger-tip controls on the operator's deck of the sinking cage. Four stout air pistons, mounted beneath the cage, position the telescopic boom. Piston action of the boom then thrusts the clamshell toward the muck pile. Two-way air pistons enable the clamshell to pick up a healthy bite, and deposit it accurately into the sinking bucket. See "New Positive-Action Mucking Machine" by Roger Pierce, *E&MJ*, May 1955, pp 82-84.



Traveling Crane-Type Labor Saver

Riddell Shaft mucker features speedy clamshell control from operator's carriage mounted on shaft set. Many installations are designed for a single operator. This type was one of the first to eliminate hand mucking in shaft sinking.

Shaft Sinking Methods Go Modern

EVEN THOUGH certain mechanical principles such as the clamshell, the traveling crane, air hoist and power shovel have been known since the turn of the century, it's amazing that it has taken the mining industry nearly 50 years to adopt these labor-saving devices for one of the most arduous tasks in mining—shaft mucking. A glance at these pages is strong evidence that the industry has outlived the static age and is now really harnessing power to do man's labor. Contributions to modern shaft mucking methods have been made by engineers in Canada, Europe, South Africa, the United States and elsewhere.

In addition to the methods shown here, the following shaft mucking systems used in recent years might be cited:

1. Tandem scrapers. Two scrapers in tandem were used to muck the incline shaft at Pend Orielle Mines in the Metaline area of Washington.

2. Rocker shovel on inclines. One incline shaft was mucked with Eimco loaders. A cable wind on the drive wheels permitted the loader to move up and down the slope during loading action.

3. Self-loading skip. Bunker-Hill employed a self-loading skip with ½-cu yd bucket which was lowered to the face of an incline. Loads were picked up by the cable-operated bucket and deposited into a skip pocket.

4. Scraper ramp. A 33-deg incline shaft was mucked with a scraper ramp unit at Fisher Hill operations of Republic Steel Corp. The scraper was a 5-cu ft semi-box type.

Overcast Air Loader

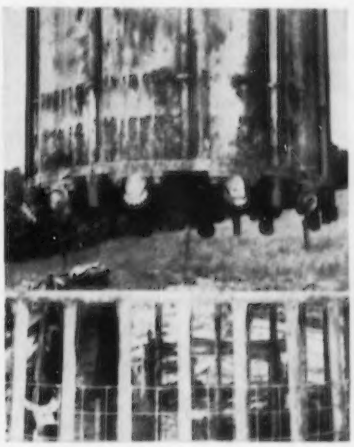
This Eimco loader recently completed a shaft mucking job in a 37x14-ft West Virginia coal shaft. The loader filled a 3x5-ft diameter bucket in a single pass. Two buckets were used.

Air-Powered Grab

Free-State Geduld No. 1 shaft was mucked with two of these air-powered grabs developed by Anglo-American Co. Two grabs excavated a 5-ft round (275 tons) in less than four hours.

Orange-Peel Grab

Independent and flexible action of the segments of this grab enabled Vlakfontein Gold Mine to cut time for cleaning up operations in the No. 2 shaft by about 50%.

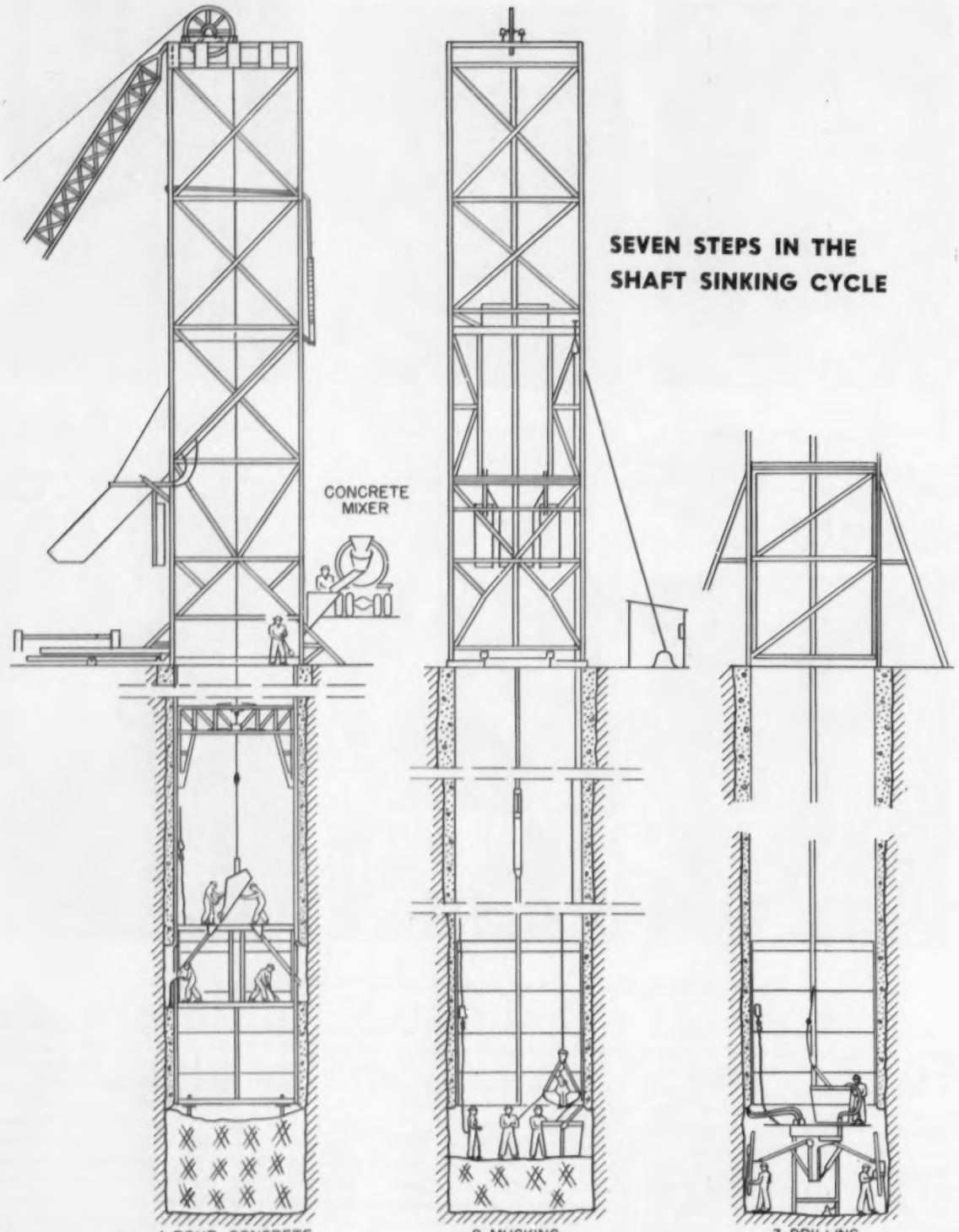


75-In. Rotary Rock Borer Speeds Mine Shaft-Sinking Job

This 75-in. rock borer fitted with 12 rotary cutting bits was used to penetrate limestone at a rate of 4 ft per hr, and sandstone at 1 ft per hr at the Trotter Coal Co. operations in West Virginia. The borer was designed and built by Coal State Construction Co., Morgantown, W. Va. **Photo, center,** shows the borer. **Photo at left** shows the clean bore of the shaft. **Photo at right** shows the sinking unit complete with boring unit and a power section including a 25-hp motor for drill rotation, a vacuum pump to remove cuttings, and a 5-hp hydraulic pump to deliver oil to the 15-in. jack that exerts pressure on the cutters.

The 25-ft, 10-ton cutting unit suspended in the photo at right consists of a cutting ring on which 12 Hughes roller cutters are mounted. Cutters are arranged in pairs facing opposite directions, and cut a 4-in. kerf. A 69-in. outside-diameter barrel fits over the core as the cutters move downward. A 36-in. cuttings compartment is used as a settling tank for cuttings drawn up from the bits by a vacuum pump. This section has capacity to hold solids drilled from the 4-in. kerf around the 67-in. core. Twelve 1¼-in. pipes, equally spaced around the exterior of the barrel, lead from the vacuum pump through ports after the drill is hoisted to the surface. After a 67-in. core has been cut, the drill is pulled out of the hole by a 150-hp mine hoist. Coal State Construction is run by the six men who developed the drill: Victor Zeni, Albino Zeni, Angelo Zeni, Germain Zeni, Charles Swope and Reno Viola. The contractors have expressed the view that many more shafts and escapeways will be put down if costs of putting them down is kept low enough. Photos and text reproduced here through courtesy of *Coal Age* which published full details in "New Drill Cuts 75-in. Hole," January 1955, pp 81-83. This shaft was equipped with a friction-drive hoist.

SEVEN STEPS IN THE SHAFT SINKING CYCLE



1. POUR CONCRETE CREW
FOREMAN-BOTTOM
3 MINERS-BOTTOM
1 MINER-COLLAR
1 TOPLANDER-COLLAR
1 MUCKER OPER-BATCH PLANT

2. MUCKING CREW
FOREMAN-TOP(OR BOTTOM)
2 MINERS-BOTTOM
2 MINERS-COLLAR-CLEAN CAGE-DRIVE TRUCK
1 TOPLANDER-COLLAR
1 MUCKER OPER-BOTTOM

3. DRILLING CREW
FOREMAN-BOTTOM
4 MINERS-BOTTOM
1 TOPLANDER-COLLAR
1 MUCKER OPER.-LEVEL DUMP & HAUL ROAD

Mechanical Planned Cycling Speeds Carlsbad Shaft Job

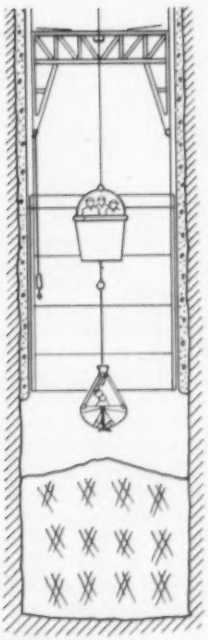
JAMES A LILLY

OUTSTANDING SHAFT-SINKING RECORDS were made at the National Potash Co. property in the Carlsbad Basin of New Mexico through careful planning of cycling of drilling, mucking and concrete emplacement, and use of the best mechanical devices available to save labor. National Potash Co. is owned jointly by Freeport Sulphur Co., and Pittsburgh Consolidation Coal Co. Bids for the two 15-ft diameter 1,886-ft deep shaft jobs were solicited from 13 contractors, and the award made to McKenzie & Whittle constructors.

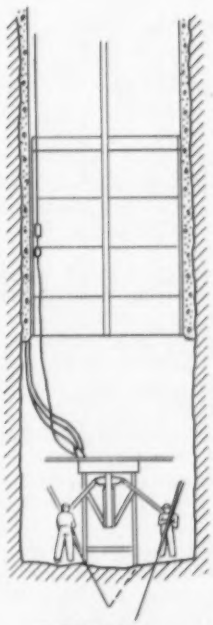
Since the contractors were experienced in tunnel driving and other heavy construction work but not in shaft sinking, they were not bound by conventional concepts of shaft sinking techniques; and surveyed the field for the best methods available. Attention was directed to the C. Kremer Bain method which resulted in unprecedented safety rec-

Mr. Lilly is project engineer of McKenzie & Whittle, Contractors. This article is excerpted from an engineering report of the project submitted to *E&MJ*, March 12, 1956 by Mr. Lilly.

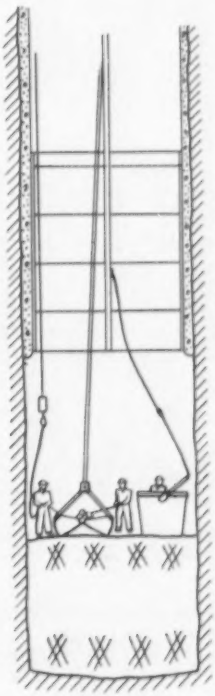
C. KREMER BAIN
Consulting engineer for the National Potash project, and developer of the "Bain" shaft-sinking system.



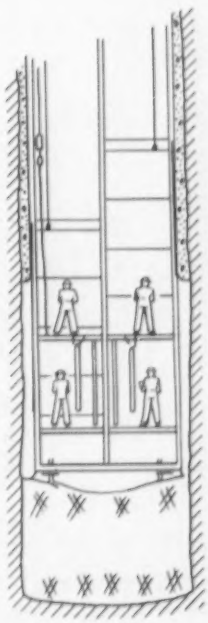
4. MUCKING (REPEAT)



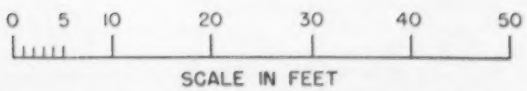
5. DRILLING (REPEAT)

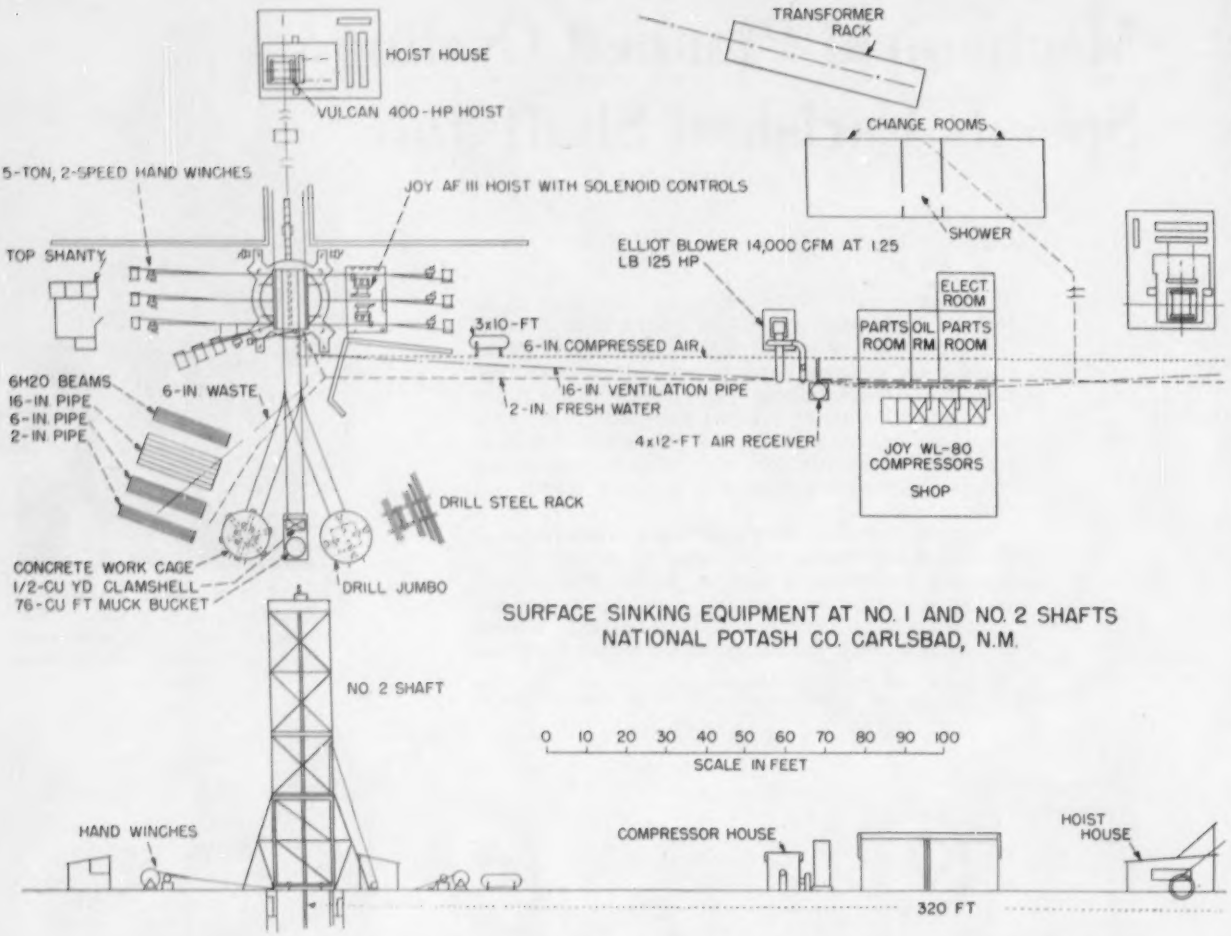


6. LEVEL OFF (REPEAT MUCKING)

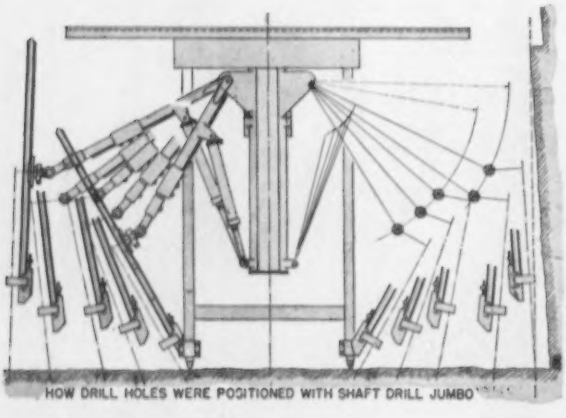


7. SET FORMS
CREW
FOREMAN–BOTTOM
4 MINERS–BOTTOM
1 TOPLANDER–COLLAR
1 MUCKER OPER–LEVEL DUMP





SURFACE SINKING EQUIPMENT AT NO. 1 AND NO. 2 SHAFTS
NATIONAL POTASH CO. CARLSBAD, N.M.



HOW DRILL HOLES WERE POSITIONED WITH SHAFT DRILL JUMBO

ords and high labor saving in the shaft sinking projects of the St. Joseph Lead Co. in southeastern Missouri. (See *E&MJ*, June 1954) Further improvements were made on this system at Carlsbad.

Conventional methods were used to sink the first 100 ft of shaft. Then headframes, hoists and other specialized equipment shown on the following page were erected. During the first month of sinking in mid-1955, 160 ft of concreted shaft was completed, bettering previous records in the area by 3 ft. During the second month, footage was increased to 220 ft in one shaft and 200 in the other.

Seven Steps in the Cycle

Seven steps in the shaft sinking cycle illustrated in the accompanying drawings are as follows:

1. The double-deck working cage is spotted on loose muck to permit pouring of concrete through form doors at three different elevations. A 1½-cu yd concrete bucket loaded at the shaft collar is used to pour at a rate of 20 cu yd per hr.

2. The bottom is mucked out with a ½-cu yd clamshell. An electric panel at the shaft bottom enables the crew to control two solenoid-operated air hoists at the shaft collar. Two 76-cu ft sinking buckets are loaded alternately.

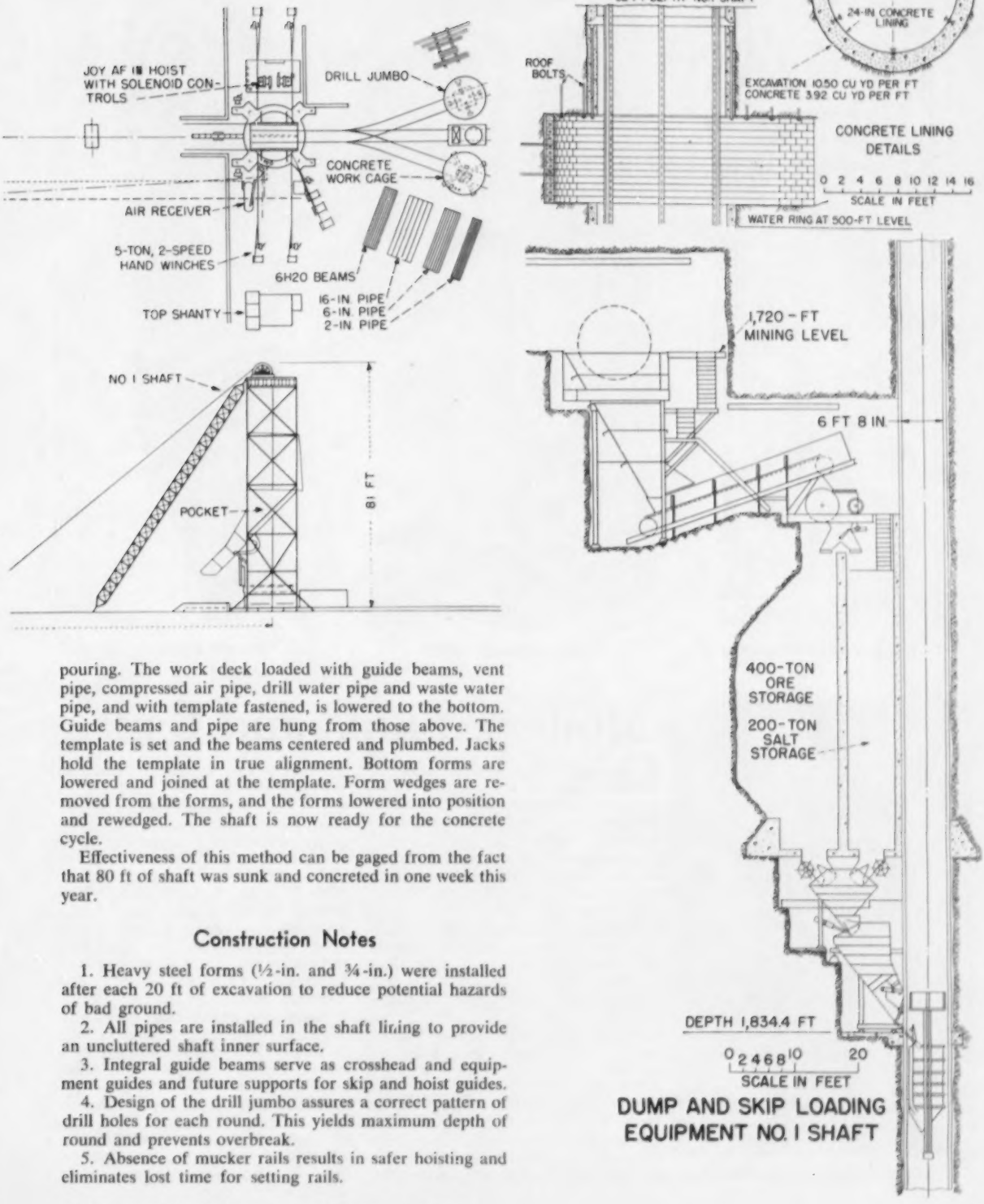
3. The Bain-type drill jumbo shown on the next page is used during the first drill cycle. This unit is equipped with air-motor feed drills and hydraulic arms which permit precise positioning of the drills for the 68-hole V-pattern used for each round. Steels are 6 and 12 ft long. Round depth is slightly more than 10 ft. Rounds are loaded with 12 sticks to the hole and fired with 6 periods of millisecond delays.

4. Mucking cycle. A repeat of (2) above.

5. Second drill cycle. A repeat of (3) above.

6. Leveling cycle. Mucking tools are used to level broken rock to 21 ft below the forms.

7. The final cycle consists of setting forms for concrete



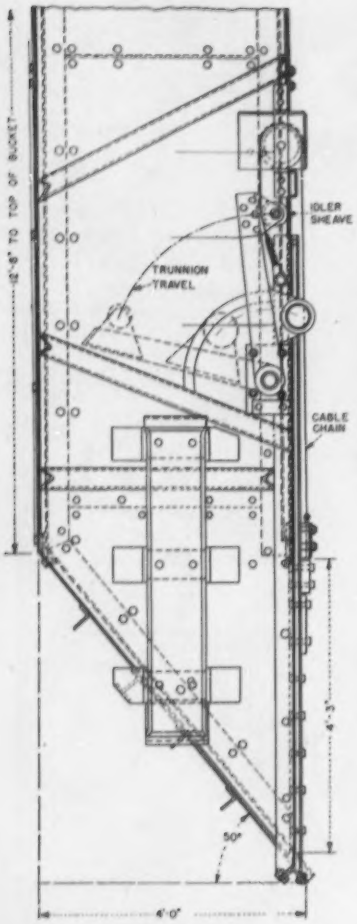
DUMP AND SKIP LOADING EQUIPMENT NO. 1 SHAFT

pouring. The work deck loaded with guide beams, vent pipe, compressed air pipe, drill water pipe and waste water pipe, and with template fastened, is lowered to the bottom. Guide beams and pipe are hung from those above. The template is set and the beams centered and plumbed. Jacks hold the template in true alignment. Bottom forms are lowered and joined at the template. Form wedges are removed from the forms, and the forms lowered into position and rewedged. The shaft is now ready for the concrete cycle.

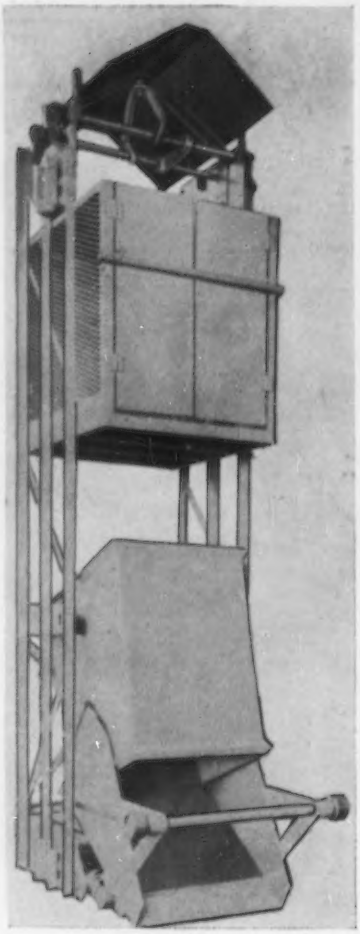
Effectiveness of this method can be gaged from the fact that 80 ft of shaft was sunk and concreted in one week this year.

Construction Notes

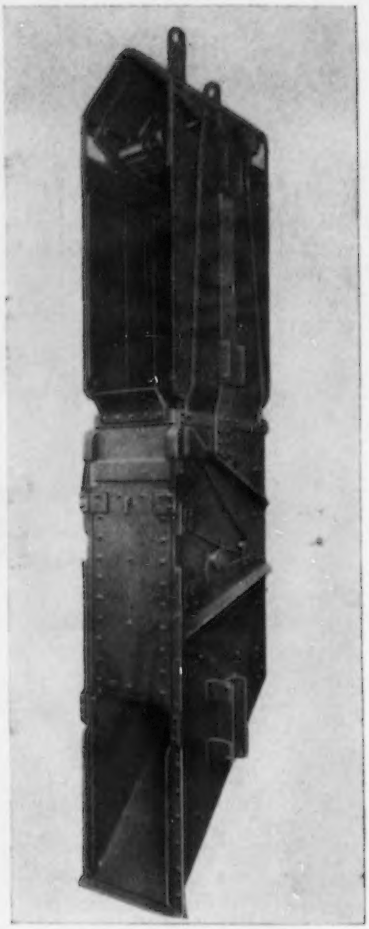
1. Heavy steel forms (½-in. and ¾-in.) were installed after each 20 ft of excavation to reduce potential hazards of bad ground.
2. All pipes are installed in the shaft lining to provide an uncluttered shaft inner surface.
3. Integral guide beams serve as crosshead and equipment guides and future supports for skip and hoist guides.
4. Design of the drill jumbo assures a correct pattern of drill holes for each round. This yields maximum depth of round and prevents overbreak.
5. Absence of mucker rails results in safer hoisting and eliminates lost time for setting rails.



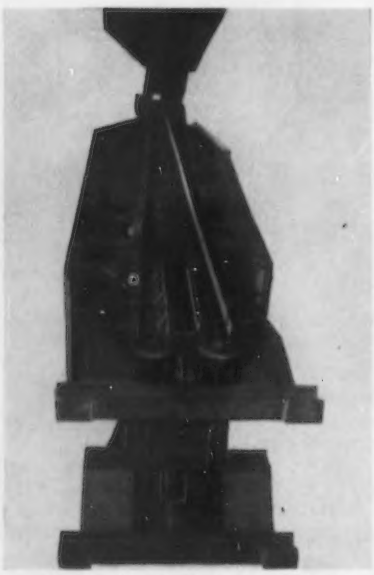
1. Type used by Anaconda.



2. Skip and cage assembly.



3. Cage and slide-gate skip.



4. New installation at San Manuel.

Modern Skips and Cages

1. Automatic bottom-dump skip at Anaconda enabled the company to increase tonnage hoisted per day by 60%. Full mechanical details shown in *E&MJ*, September 1948.

2. Combination skip and cage is equipped with automatic, fast dumping, no-spilling gate. Gravity keeps skip closed. Vulcan Iron Works Co., Denver, Colo.

3. Slide-gate bottom-dump skip beneath cage holds 5 tons. Unit was designed for a South African copper mine. Gate is raised when rollers enter dumping guides. Vulcan Iron Works, Wilkes-Barre, Pa.

4. Bottom-dump skip at San Manuel Copper Corp. holds 18 tons. Skips are designed to travel 3,000 fpm on steel guides. See *E&MJ*, April 1956 for description of hoisting installation and headframe dumping system.

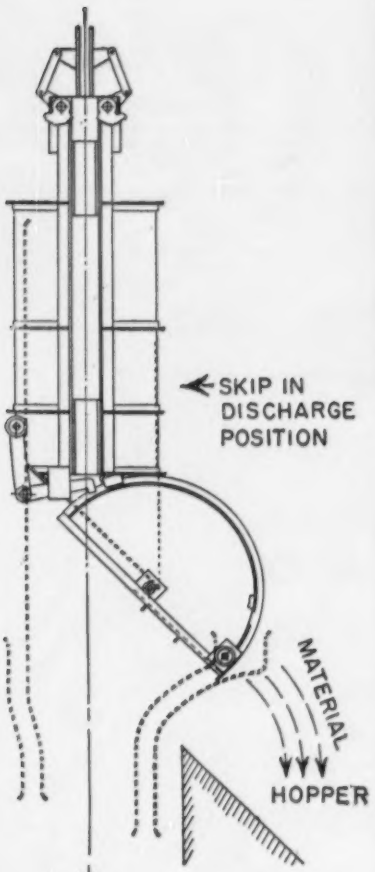
5. Overlapping chute serves both as slide and gate when rollers enter roller guides as shown above. A second roller opens the latch at left of guides. Vulcan Iron Works, Wilkes-Barre, Pa.

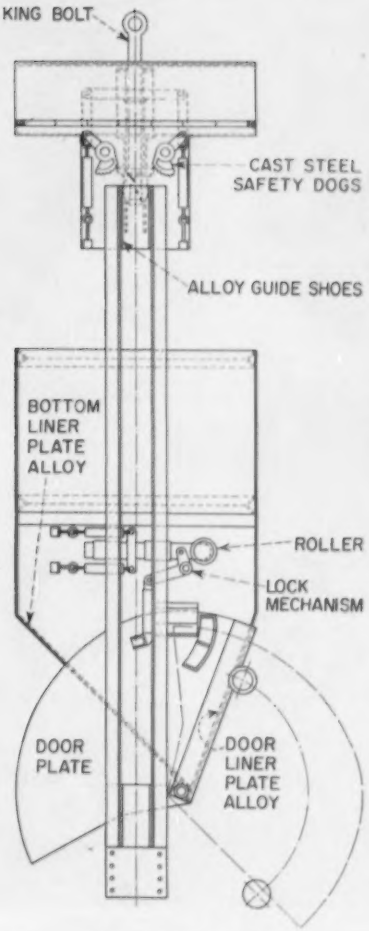
6. One set of guide rollers controls movement of drop doors which serves as gate and chute. Second roller above operates locking mechanism. All important structural members are made of alloy steel C. S. Card Iron Works, Denver, Colo.

7. Double-pivot design enables skip to swing clear of shaft and drop load through opened door. Note locking hook at bottom. Lake Shore, Inc., Iron Mountain, Mich.

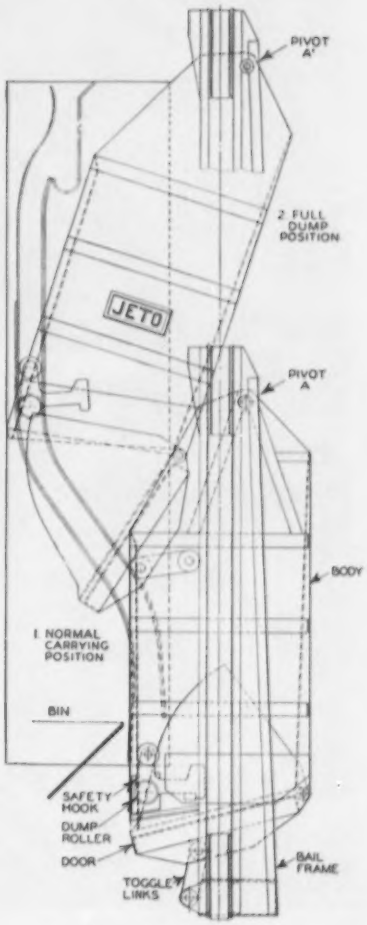
8. Substitution of aluminum for steel in this Kimberly-type skip saved about 25% in weight. This unit is equipped with splash boards, bonnets and safety latches. Lake Shore, Inc., Iron Mountain.

9. Custom-built circular double-deck man cage is part of a pushbutton elevator-type installation in a circular shaft. Connellsville Mfg. & Supply Co., Connellsville, Pa.

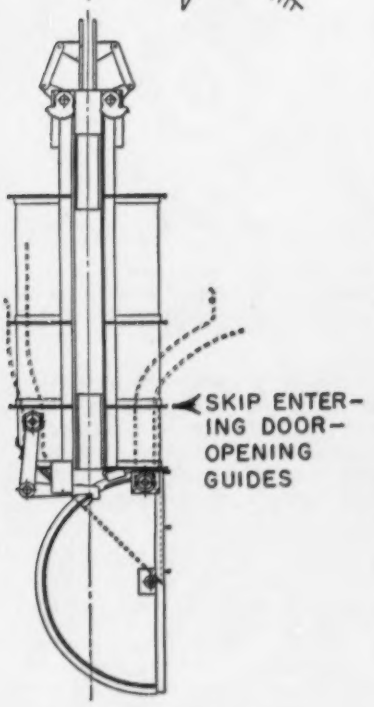




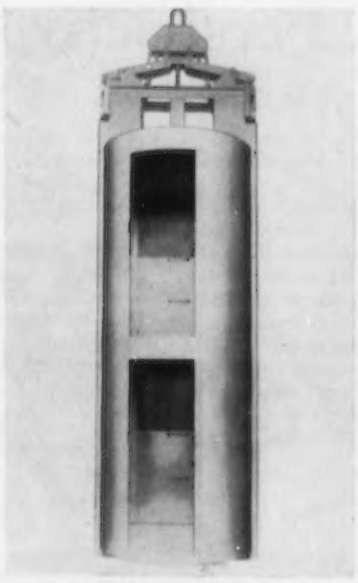
6. Drop-door gate chute.



7. Swing-out bottom-dump type.

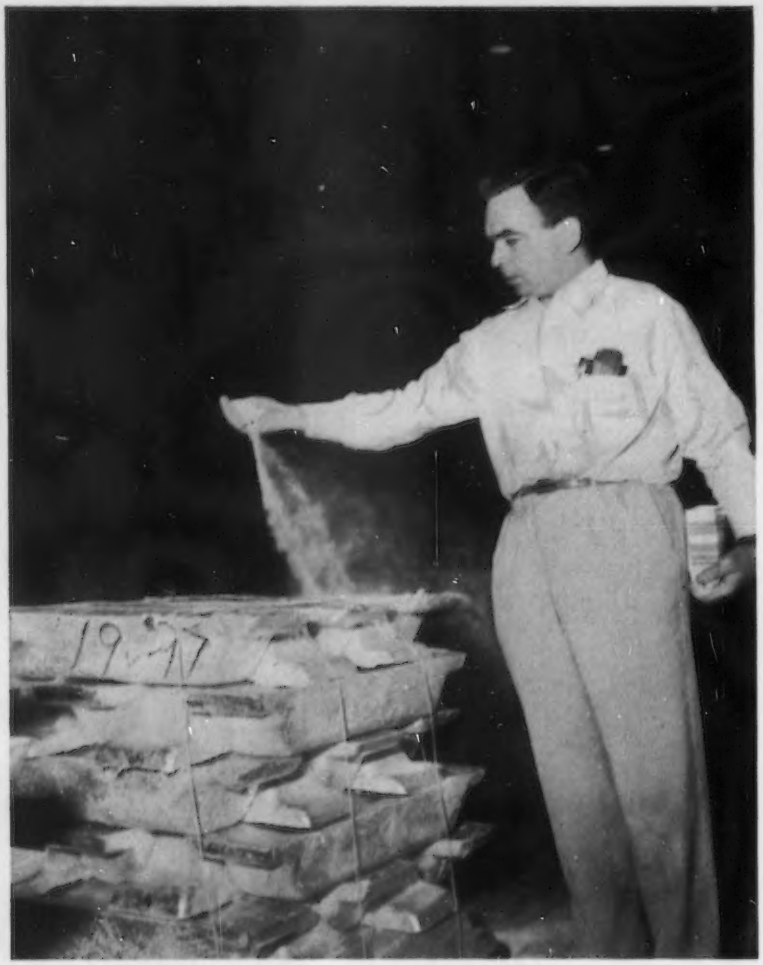


5. Overlapping chute type.



8. Double-deck cylindrical cage.

9. Light-weight aluminum-steel skip.



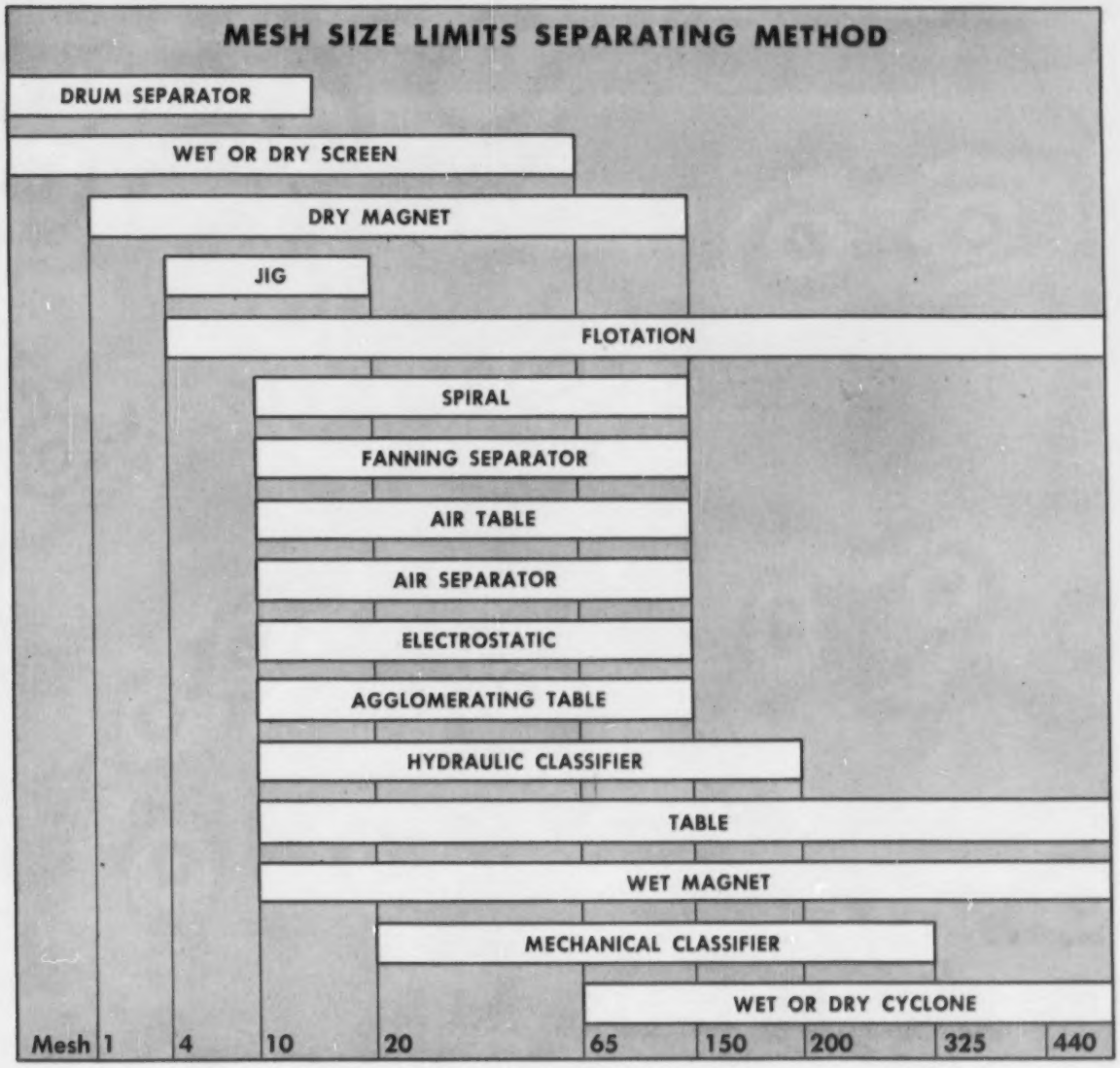
Metallurgy in Perspective

WITH THE INCREASING NUMBER of "border incidents" along the ever vaguer boundaries between ore dressing, metallurgical engineering and chemical engineering, men faced with the problems of extracting values from ore must take a broader and broader view of their fields. This has been the approach on the following pages. We are dealing here with some of the important basic problems like the separation of solid particles of one kind from solid particles of another (solid-solid separation). What equipment and methods are available to solve these fundamental problems involved in all extractive operations? What are their advantages? Their limitations?

Much space is devoted to the extraction of uranium not only because it is a subject of intense general interest, but because it illustrates so well how difficult it is in modern technology to draw the line between the classical concepts of chemistry and metallurgy.

Even working in this broad framework, we cannot afford to lose sight of some of the important details. For this reason there are also included panoramas of supplies available in key spots of modern metallurgical practice—complete rundowns on items like flotation reagents, ion exchange resins, refractories.

For your own reference or for widening the perspective of the young men on your staff, we think you will find it profitable to keep these notes, tables, charts and ideas handy the year round.



Separating Solids from Solids

WITHOUT EXCEPTION the equipment we can choose to size or concentrate is limited by the mesh of grind necessary to liberate the valuable. Coarse grinds mean high recoveries at low cost. Fine grinds increase the cost of separation and result in higher grades, but at a sacrifice in recovery.

Consider the advantage of splitting feed into as many narrow fractions as is economic and sending these fractions to separate concentrating units. There is some evidence to indicate that each flotation cell should receive a definite particle size or run at a different impeller speed or both. The narrower the particle range, the better the separation.

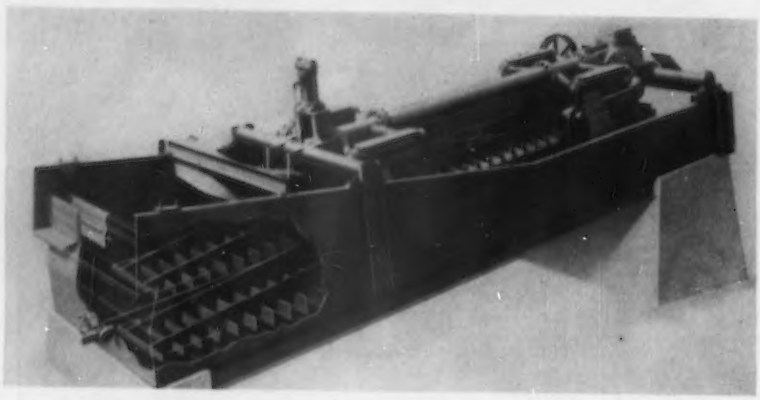
Gravity carries the ball in all our separating problems, except with magnetic, electrostatic, flotation and cyclone processes. Even in these exceptions, gravity makes its presence felt, either by limiting the sizes we can handle or by increasing the effectiveness of the applied force.

When the gravity of one mineral less the gravity of water—is divided by the factor gravity of the ore or other component less gravity of water—a number called the concentration criterion is obtained. This criterion determines the particle size at which gravity separation can be applied.

If the criterion number is . . .	Effective separation is possible to . . .
above 2.5	200 mesh
2.5 to 1.75	100 mesh
1.75 to 1.50	10 mesh
1.50 to 125	4 mesh
1.25 and under	switch to other methods

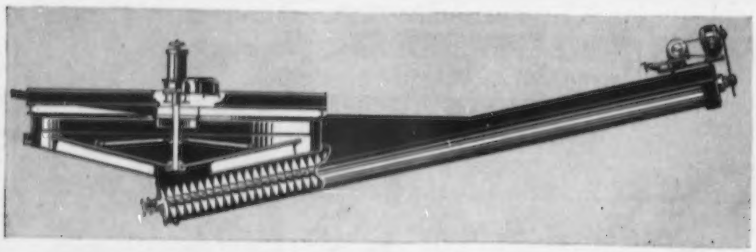
On the following seven pages we will show many of the gravity and non-gravity units that you can use to separate solids from solids, to size, sort or concentrate.

Screens can size, either wet or dry. They can also dewater, wash, scalp and concentrate (reclaiming heavy media for example). At 8 mesh, one sq ft cloth can handle about 0.5 tph with 25% oversize. Economic limit on screens is about 65 mesh, but screens are being used on special jobs down to 200 mesh. Screens come with one, two or three decks. They can be stationary, gyratory-sifter, suspended-gyratory, rotary, reciprocating or vibrating. Concenco screens at left are made by Deister Concentrator Co.

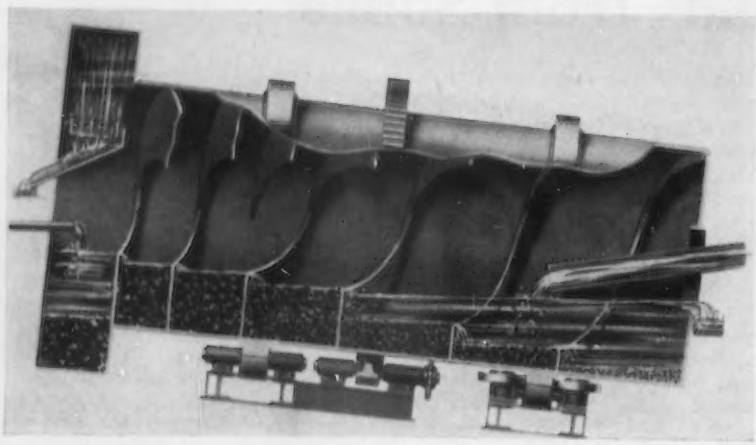


Rake classifiers handle up to 12,000 tons in 24 hr in the 20- to 100-mesh range. Underflow densities between 80 and 83% can be obtained. Dorr-Oliver, Inc. model at left comes with from one to six rakes. Multiple rakes work in rotation. Overflow in this unit is controlled by varying per cent solids on feed and by varying rake speed. The greater the per cent solids, the higher the rake speed, the coarser the separation.

Here are the Types of Units Available, That You Can Use, Alone or



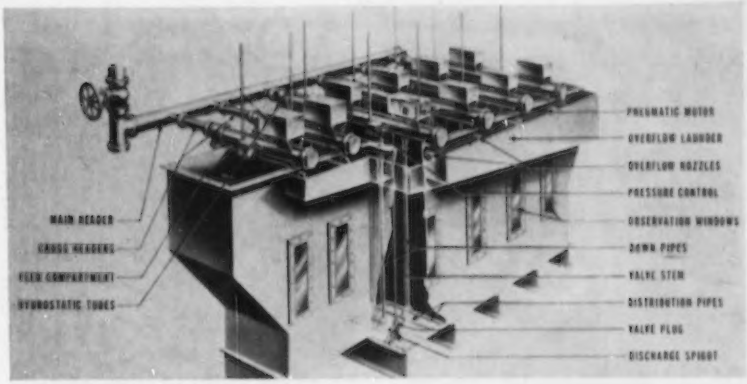
Hydro-classifier, by Hardinge Co., Inc., works best in the 65 to 325 mesh range. It uses automatic rake-lifter and twin spiral classifier-conveyors to remove underflow. Pool depth can be up to 6 ft, giving 700-sq ft settling area at 30-ft diameter. One coal washery uses a 30-ft unit to produce 45 tph 72% plus 48 mesh underflow and 9 tph 78% minus 100 mesh overflow. Units can handle up to 300 tph.



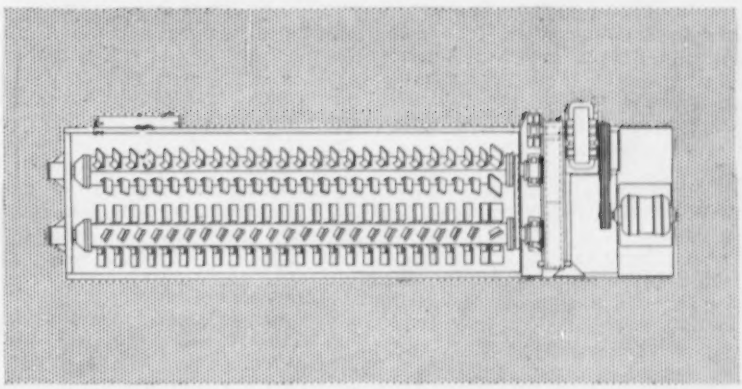
Counter-current classifiers, like the Hardinge Co., Inc. model at left, have hollow spiral-flight wrapped around the inside of the rotating shell. Sands move counter-current to water and discharge by elevator. This unit has only one moving part, can be acid-proofed. Rotating speed, dilution, pool depth and sand take-off can be varied.

Classifier can be stopped without unloading and cannot be jammed by tramp or oversize. Capacity can be as high as 43 tph on 40% minus 200 mesh overflow. It is used as Heavy Media vessel. The 10-ft diameter model will handle up to 1,000 tons, minus 8-in. feed per hour, when used for a Heavy Media separation.

Hindered-settling classifiers separate feed, four mesh or finer. Dorr-Oliver, Inc. models will make as many sizes as there are rows of pockets in the unit. The 21.5-pocket jet-sizer will make 5 cuts at 90 tph. It can size, deslime or concentrate. Sizer uses about 4 tons water per hour.



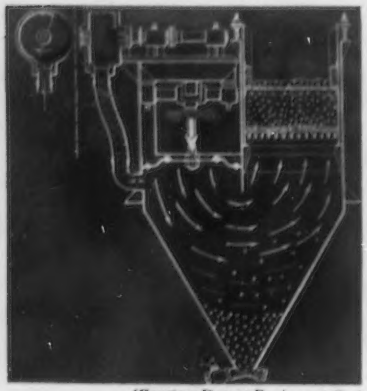
Log washers wash clay, silt and fines from many gravity concentrated ores. You can make your own, but you can buy better ones like the Allis-Chalmers unit at right. Log washers are used for medium-sized ore with moderate amounts of clay. If the ore contains lots of clay or is very large-size, try a blade mill instead. For easily washed sand, use a sand scrubber. Logs are available with 20-in., 24-in. and 35-in. blade diameters, in tanks up to 35 ft long. At log speed of 14 to 25 rpm, a 35-in. paddle will treat up to 150 tph on 60 to 150 hp.



in Combination, to Deslime, Dewater, Scalp, Size or Concentrate

Drag-belts, like the modified Esperanza classifier used by Magna Copper Co., can keep overflow at 91% minus 325 mesh. Belt runs at 19.5 fpm on 0.9 hp. Feeding 25% solids, Magma gets 20% solids overflow with oversize discharge at 55% solids. Belt handles 17.5 tph with 103% circulating load.

Spiral classifiers get pretty big—this is Western Machinery Co.'s 96-in. diameter model. This spiral will make up to 700 tons minus 200 mesh overflow and rake out 12,000 tons sand in 24 hours. Slope and pool depth adjust to control separation. For coarse separation down to 65 mesh use high weir design and 3- to 4-in. slope per ft. On 48 to 150 mesh work, use standard weir and 3- to 4-in. slope. If you work at minus 100 mesh, try submerged weir and 2- to 3-in. slope.



(Courtesy Denver Equipment Co.)

JIGS make a quick coarse concentrate in ½-in. to 14-mesh particle size range.

(Courtesy Virginia-Carolina Chemical Corp.)

COVERING the shaking table with an all-aluminum deck will cut repair costs.

(Courtesy Denver Equipment Co.)

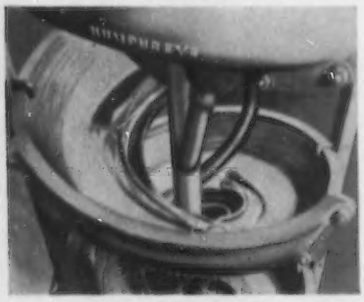
BLANKET TABLES treat heavy-mineral slimes at up to 150 tpd, tilt to unload.

Relative Gravity Separation

IN SIZING AND CONCENTRATING, we still depend heavily on specific gravity or settling velocity (relative gravity) of the mineral in water. Of the many machines invented during the past century, only the jigs, tables, spirals and the new Fanning separator remain in good standing.

Jigs still come in two designs. One has moving screen. The other has moving medium. For coarse feed, use longer and slower pulse strokes. Jigs work in the ½-in. to 14-mesh range. For coarser work, try Heavy Media process. For finer work, try tables, spirals and the Fanning. Jigs do a good job of getting a quick, coarse concentrate on lead-zinc ores. They can also help scalp out calcite ahead of flotation.

Shaking tables take over at 8 mesh and finer. On plus 150 mesh feed, tables can produce rougher concentrate at up to 10 tph per deck. Cleaning rates go as high as 3 tph. If the pulp is smaller than 48 mesh or has many fines, flotation would be better.



(Courtesy Humphreys Investment Co.)

FIVE-TURN spirals treat ores and six-turn units are designed for non-metallics.

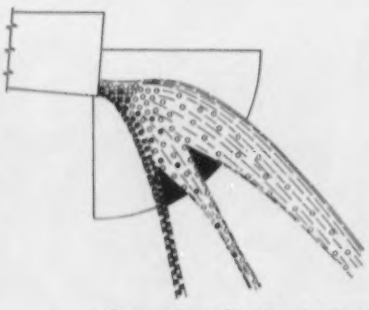
Spirals have made big inroads into areas dominated by tables since 1900.

Small, pilot-tables can help you keep visual track of tailing losses.

Agglomerating tables, like the one developed by Chapman and improved by his son, Charles Chapman, Virginia-Carolina Chemical Corp., Nichols, Fla., treat pulp with low-separating criterion. They agglomerate similiar minerals with oils and then separate them on the table. Best particle range is minus 8 to plus 65 mesh. They will work on feed as fine as minus 200 mesh, but the capacity will be low. Keep the particle range as narrow as possible for best results. Try spirals or Fannings ahead to deslime and take off oversize.

V-C tables have disposable all-aluminum decks. They last about three years on pebble phosphate.

Tables can be right or left handed. They take many deck forms: Wilfley, National or Butchart, Card, Deister-Overstrom, Concenco, Garfield, and the Plat-O table.



(Courtesy Carpco Manufacturing, Inc.)

SMALLEST, most compact unit available, the Fanning, takes minus 8 mesh.

The Buckman tilting concentrator is a blanket table. It is designed for minus 150-mesh pulp. Many heavy-mineral slimes are handled on this table at up to 120 tpd. Denver-Buckman has either 5 or 10 decks. It takes pulp for up to ½ hr, then tilts so that collected heavies can be washed off into concentrate bin. Recovery is low, but grades can be high. It works best on native metals.

Humphreys spiral concentrators treat feed at minus ½-in. They work best on narrow range feed. Use five-turn spiral for ores and six-turn spiral for non-metallics. For best results use a 3-turn spiral to clean rougher concentrate. Capacity can be 1.5 tph at best. Using deslimed feed will improve grade, but it will cut down your throughput.

The Fanning ore concentrator has no moving parts, separates wet feed on relative gravity. As pulp flows down the narrow shute heavies sink into lower pulp zones. Pulp discharges from end of sluice onto the fan. The light material on top of the pulp moves faster and travels further out on fan plate. Heavies move slower and not so far out on the fan.

Two wedges at the bottom of the fan are adjusted so that they separate into heavies, middlings and lights.

This is the smallest, most compact and cheapest separating unit on the market. It can do everything that a table can do and do it in one-third the space. A 65-tph three stage fan plant needs only a 22x31x7-ft area. Three fans will fit on a table top.

Slope and feed rate can be varied. Many electrostatic and magnetic plants use Fanning separators for roughers. They work on minus 8 mesh feed.

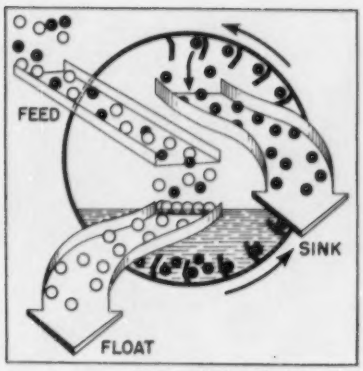
Absolute Gravity Separation

MINERALS CAN BE CONCENTRATED in quicksand, salt water, galena, dense organics, ferrosilicon and magnetite on an absolute gravity basis. One such process, the patented Heavy Media Separation process, uses magnetic media. This patent is held by American Zinc, Lead & Smelting Co. and licenses are issued through American Cyanamid Co. You can buy and use any of the equipment shown below; but if you use ferrosilicon media process you will have to pay a royalty to American Cyanamid Co. Royalty is based on tonnage, grade and value of mineral concentrated. Not all the models available are shown below.

Drum separators work best on coarse feed from 8 in. down to 10 mesh. Classifiers compare with drums. These two types can make a three-product separation and can take large surge loads. Cones can treat rock up to 10-in., but general practice is to work on minus 1.5 in. with fines best feed.

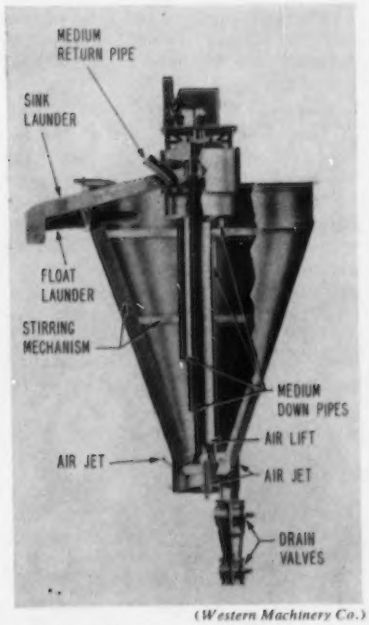
Operating costs in the U. S. run about 25c a ton feed; in Europe it is slightly lower; and in Africa, a 100-tph unit can operate at 4d per ton. Installation costs on a 25-tph unit will run about $30,000 and about $140,000 on a 1,000-tph model. The four-cone, 12,000-tpd gravity plant of Premier Diamond cost £750,000.

Today's plants use galena, ferrosilicon or magnetite media. Galena is the cheapest, can be recovered by flotation. Ferrosilicon and nickel mixture will form densities up to 3.7. Ferrosilicon alone will give gravity up to 3.4. Ferrosilicon mixes with magnetite to form gravities up to 2.75. Magnetite alone sets gravity at 2.2. Salt solutions give maximum gravity of 1.5. Pentachloroethane could be used instead of salt, except for cost. Acetylene tetrabromide can be used for gravities up to 2.95, costs 55c a lb.



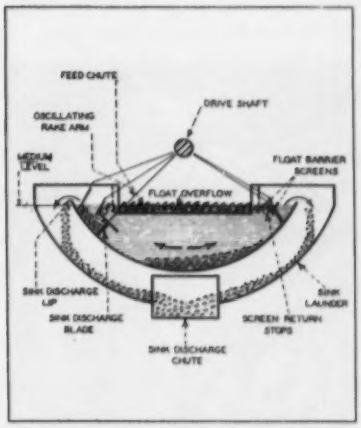
(Courtesy Western Machinery Co.)

DRUM separators operate at low cost, take up less floor space than a cone.

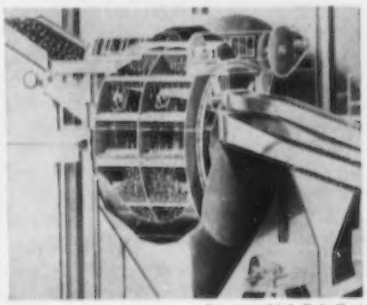


(Western Machinery Co.)

TWO PRODUCT separation on feed up to 10 in. is possible in large size cones.



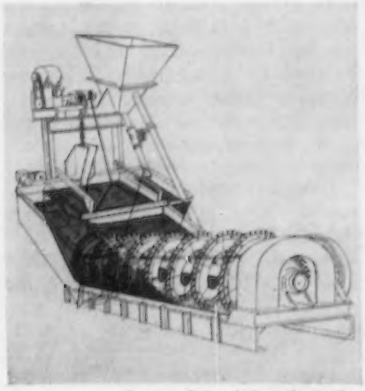
RAKE ARM sweeps out sink from Ore & Chemical Corp.'s stationary vessel.



(Courtesy Link Belt Co.)

DRUM separators make three products on feed in the 10-in. to 10-mesh range.

GALENA is recommended medium in Sink & Float Corp.'s 10-tph package unit.

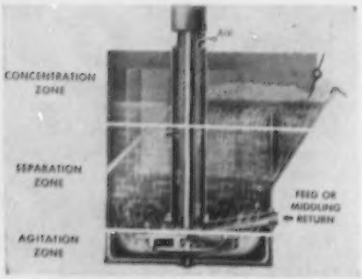


(Courtesy Colorado Iron Works Co.)

SPIRAL classifiers make three-product separation, can shut down under load.

DESIGNED for coal, Wilmot Engineering Co.'s separator will also handle ore.

Flotation, Wet Cyclones and Wet Magnets



(Courtesy Denver Equipment Co.)

(Courtesy Tennessee Corp.)

WE HAVE MANY modern flotation machines to look over. The three shown here are not all the types available (Agitair for instance). These three represent the basic designs and what they can do best. The wet cyclone is perhaps the biggest thing to hit milling in the last decade. Wet magnets will concentrate and can also dewater.

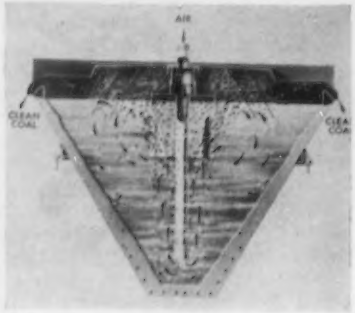
The Fahrenwald sub-aerated impeller cell can take feed as coarse as ¼ in. Gates between cells and sand relief holes under the gates pass pulp from one cell to the next. This cell can be used with atmospheric pressure, super-charged air and without air.

Sand relief lets coarse sand move under the gate, cutting abrasion and reducing sanding. Size of sand relief hole can be varied.

According to Denver Equipment Co. it is not necessary to drain cells on shut down, but don't try it if your pulp is dense and tends to settle.

Pulp level is controlled by weir gates, either mechanical or wood-slats. Tennessee Copper has novel weir control (see above). They cut weir box into back of the cell, so that they can raise or lower weir height without diving down between the cells.

Any one of several impeller types can be used. Rubber covered is best. Advantages are low horsepower, good stage reagent addition and better grades. Twenty-four 56-in. cells treat 5,600 tons phosphate rock a day at one plant. At a copper mine, 120 fifty-six inch cells handle 5,000 tons copper ore a day on the rougher circuit. It comes in wood or steel, can be rubber-lined.



Air cells, such as Western Machinery Co.'s Steffensen unit, use air from down pipes for agitation. They have no moving parts. Original cost is less than mechanical cell cost. The Steffensen was designed to treat coal, works best on plus 65 mesh feed.

(Courtesy Equipment Engineers Inc.)

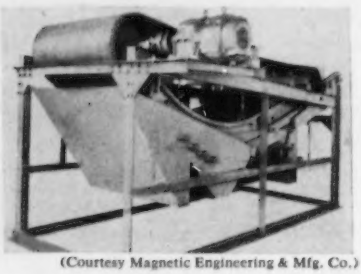
In wet cyclones, abrasion is a problem, as it is in most pumps, according to Herkenhoff, but it can be reduced to a minimum by proper choice of liner material. Rubber is used for classification units. On minus ⅛-in. taconite, rubber or Linatex will outwear ordinary NiHard.

Circular nozzles wear better than square. ¾-in. rubber lasted through 300,000 tons taconite ore. NiHard apex disks lasted about ¼ as long. In the case of the pumps at Erie, the impeller lasted about 600,000 tons with other parts having life up to 1-million tons, when rubber lined. These pumps were 8x6-in. SRL-C, 55 hp and operated at 930 rpm. Parts other than impeller can be relined with Linatex.

(Courtesy Western Machinery Co.)

Rotor-stator impeller cell is gravity fed, with no gates between impellers. Wemco says that size for size, the Fagergren's capacity is 1.5 to 2 times any other make. Power consumption is low. Can be shut down without draining cell bank.

Cell sizes up to 66 in. are available. A four-impeller bank can handle up to 1,015 tpd. Twelve-impeller bank can take up to 3,050 tpd. Reagent costs in Fags is said to be lower than other type. One lead-zinc operator cut reagent cost from 12.7c a ton to 7c per ton by switching from 6 mechanical cells to 4 Fags. Some operators feel that this machine can't take the coarse rock that a Sub-A will handle. It's best for cleaning and scavenger work, according to many.



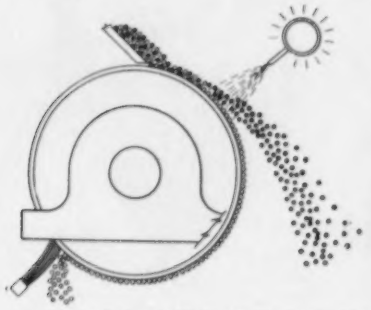
(Courtesy Magnetic Engineering & Mfg. Co.)

Wet magnets can be of two types: a drum or belt, with the belt in or out of the slurry.

Wet drums can be used to cob rod and ball mill discharge. They can be used at high intensity for high recovery. Either permanent or energized magnets can be used. Wet drums can be used to produce a finished concentrate and to dewater magnetic material. They come in sizes up to 36-in. diameter. Maximum particle size is ⅜ in. They can handle up to 40 tph magnetite.

Wet belts handle mill discharge under ⅜ in. Sudden surges cause belt to slip. Up to 99% recoveries have been reported. Magnets can be either type.

Electrostatic and Magnetic Separations



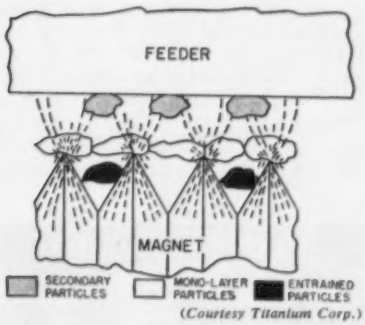
(Courtesy Carpco Manufacturing, Inc.)

ELECTROSTATIC SEPARATORS work on kiln-dry material only. They can separate by pinning one mineral to the rotor, by lifting another from the rotor or by combining pinning and lifting.

Lifting method uses a large diameter electrode and depends on mineral to take a surface charge. It can separate minerals of same relative conductivity but different abilities to assume this surface charge. This type separates only 10 to 20% of total separable mineral per pass. It is affected by temperature and humidity.

Pinning type uses a needle point or fine wire discharge electrode. It charges surface of poor conductors and pins them to rotor. It separates on conductivity alone. Unit has high degree of separation per pass, about 80 to 85%. Recycle loads back to roll tend to be high, up to 50%. It is not affected by temperature or humidity.

Combined lifting and pinning devices use both types of electrodes. They pin good conductors if not controlled and lift others. High (85 to 98%) degree of separation per pass.



(Courtesy Titanium Corp.)

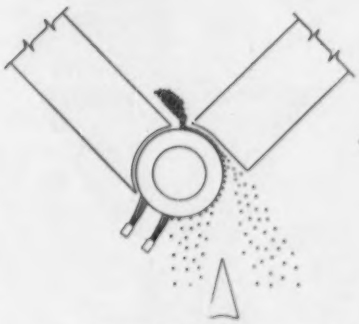
A NOVEL MAGNETIC SEPARATOR was developed and patented by Theodore Perlman, Titanium Corp., Natal, Union of South Africa. This unit uses peaks and valleys on a machined roll to collect one layer of particles at a time. Up to 10 rolls work as a unit, with each roll tooled to attract one kind of particle or one size. Surface designs on rolls were established by trial and error.

Combined type will separate minerals . . . by pinning to the rotor— Anorthite, apatite, baddeleyite, barite, bastnaesite, beryl, calcite, carnotite, celestite, corundum, diamond, diopside, kyanite, epidote, feldspar, garnet, gypsum, hornblende, hypersthene, magnesite, monazite, quartz, scheelite, sillimanite, spinel, staurolite, tourmaline, and zircon; or

by lifting from the rotor— Bismuthinite, brookite, cassiterite, chromite, columbite, galena, gold, graphite, hematite, hubnerite, ilmenite, limonite, magnetite, manganite, pyrite, rutile, sphalerite, stibnite, tantalite, tungsten, and wolframite.

A 60-in. long rotor can handle 2.5 tons of feed per hour. One mill uses seven units as roughers, four scavengers, three cleaners and one recleaner high tension separator and treats 1,000 tpd of sand.

Electrostatic separation can be used on material from 8 to 250 mesh, works best on large sizes.



(Courtesy Carpco Manufacturing, Inc.)

DRY MAGNETIC SEPARATORS have one or more roll separators, each surrounded by a complete magnetic field. In multiple units the ore may be separated by setting each roll at different intensity or using all rolls at same intensity and going for higher feed rates. Works best on 10 to 200 mesh feed.

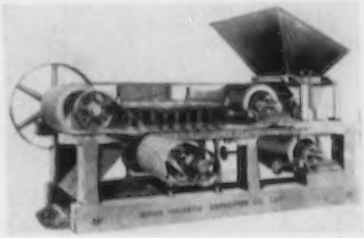
These minerals are highly magnetic . . . Magnetite and high-iron ilmenite;

while these are magnetic— Chromite, garnet, hematite, ilmenite, siderite, xenitime;

and these are weakly magnetic— Apatite, bastnaesite, biotite mica, chrome-spinel, columbite, epidote, garnet, monazite, olivene, black rutile, staurolite, tourmaline, wolframite.

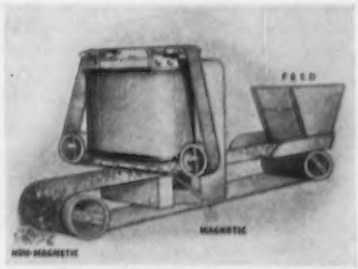
and the rest are non-magnetic— Anatase, barite, beryl, brookite, calsite, cassiterite, corundum, diamond, feldspar, fergusonite, gold, gypsum, kyanite, muscovite mica, perovskite, pyrite, quartz, rutile (red to amber), samarskite, scheelite, sillimanite, topaz and zircon.

Feed rates on dry separators generally run from 1,000 to 3,000 lb per hour per rotor.



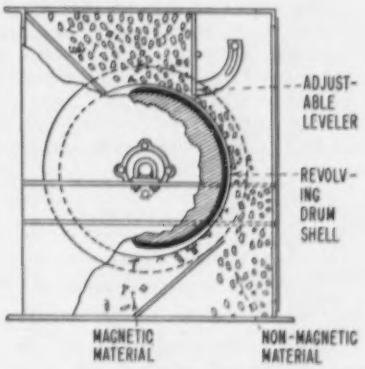
(Courtesy Dings Magnetic Separator Co.)

DRY BELT SEPARATORS, like this Dings Magnetic Separator Co. model, can handle up to 5 tph per foot of belt. Travelling belt passes under 12 coil-magnets, which lift highly magnetic material to upper belt. Magnetic material drops off belt into concentrate bin; tails fall off lower belt. High intensity pulley separators, either permanent or energized magnetics, can be used to concentrate any magnetic feed or to collect tramp material. Works best on minus ½ in. to 150 mesh.



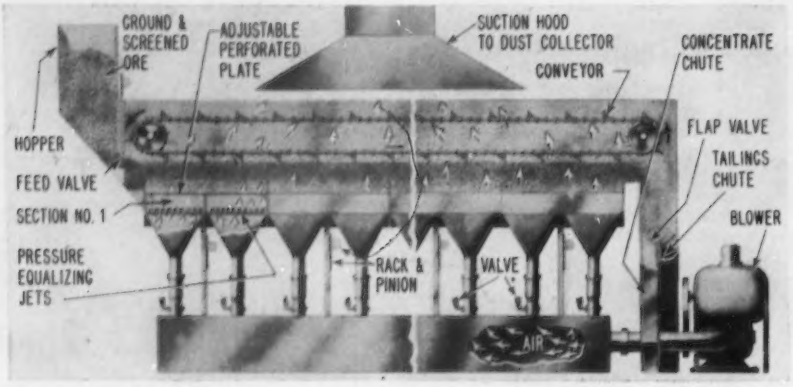
(Courtesy Magnetic Engineering & Mfg. Co.)

CROSSBELT SEPARATORS can have 8 or or more magnets and crossbelts. Each belt and magnet can be set to take a separate fraction. Capacity up to 8,000 lb per hour per foot belt width is possible. Takes minus 8 to 150 mesh feed.

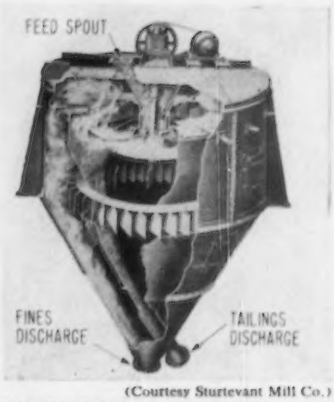


(Courtesy Dings Magnetic Separator Co.)

DRY DRUM MAGNETS can be permanent or energized. They are used to concentrate magnetic taconite at minus 1.5-in. feed. In all dry magnetic and electrostatic separators, excessive minus 150 will cause high losses.



CONCENTRATING capacity on Dry Ore Concentrator, Inc. machine is 75 tpd. Air keeps ore in fluid state and allows heavy minerals to fall into cells below.



(Courtesy Sturtevant Mill Co.)

MECHANICAL air-classifiers use centrifugal force, size to 400 mesh.

Relative Gravity Air Separation

AIR-SIZING AND AIR-CONCENTRATING units can't make an absolute separation. Some fines always end up in the coarse, and vice versa. Some of these units have capacities up to 150 tph; while others can handle only 5 to 7 tons.

Mechanical air-classifiers of the Sturtevant and Hardinge design (also, the Raymond) combine a fan and centrifugal force to make a two-product cut. Most cuts are made at 200 mesh, although the units can be adjusted to make any cut between 40 and 400 mesh.

On feed 60% minus 200 mesh, this separator can hit 40 to 50 tph and make a product 90% minus 200 mesh. They work best on minus 35 mesh feed. Sturtevant classifier will deliver 100 tph in the 40- to 400-mesh range.

Dry Ore Concentrator, Inc., Redmond, Wash., claims that its dry concentrator will recover up to 99% of the value in metallic feeds. Capacity can go as high as 75 tpd.

Ore enters by gravity and is kept in fluid state by compressed air from below. Heavy elements settle into cone cells (up to 8 cells) and fines move on out of the chamber. When cells fill with concentrate, the unit must stop taking feed and discharge the concentrate. A perforated plate in the cells is raised, lifting concentrate so a scraper-conveyor can sweep it into concentrate shute.

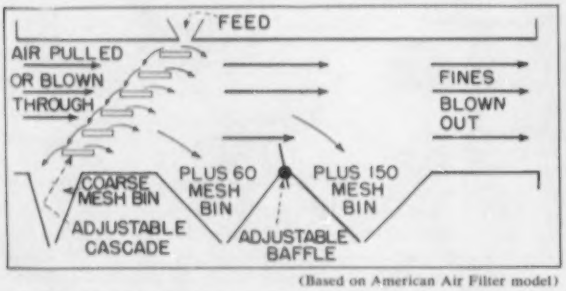
(Courtesy Hardinge Co., Inc.)

MINUS 35 mesh makes the best feed for the mechanical air separation units.

Cascade air-sizer can size at about 60 or 80 mesh, with the possibility that a coarse, a plus 60 mesh, a plus 150 and a fines can be made. Sizer feeds by gravity and separates by dropping feed down a cascade of steps. As the feed falls down the steps, coarse material falls in front and into coarse bin, while finer mesh material is blown off the back of the steps by the induced draft. A baffle between the middling hoppers helps regulate the kind of cut made.

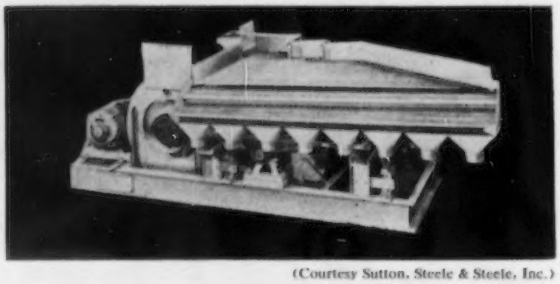
Capacity on 60-mesh split can hit 150 tph. Disadvantage is that fines may be lost, unless collected in cyclones. American Air Filter Co. holds a patent on such a sizer.

Air tables are dry shaking tables with air as feed-fluid rather than water. They will treat minus ⅜-in. ore, and work best on narrow range feeds. Air comes to the table through a porous deck, keeps feed suspended and moving. Capacity ranges from 5 to 7 tph on minimum feed, 65 mesh.



(Based on American Air Filter model)

CASCADE air-sizer drops a thin sheet of feed down cascade, blows middlings and fines through the steps and into bins.



(Courtesy Sutton, Steele & Steele, Inc.)

NARROW range feed works best on air table. Capacity varies from 5 to 7 tph with feed at minus ⅜ in. and plus 65 mesh.

Flotation Reagents*

(Letters in parentheses, after reagent name, refer to these manufacturers.)

A Rohm & Haas Co.
B Carbide & Carbon Chemicals Co.
C Ciba Co.
D Oronite Chemical Co.
E Allied Chemical & Dye Corp.
F Marathon Corp.
G W. Va. Pulp & Paper Co.
H American Gum Products Co.
J Baker Castor Oil Co.
K Emery Industries Inc.
L Industrial Oil Products Corp.
M E. I. du Pont de Nemours & Co.
N Commercial Solvent Corp.
P Minerec Corp.
Q Dewey & Almy Chemical Co.
R Sharples Chemicals, Inc.
S American Cyanamid Co.
T Newport Industries, Inc.
U Pacific Lumber Co.
V Philadelphia Quartz Co.
W General Mills, Inc.
X Armour & Co.
Y Dow Chemical Co.
Z Hercules Powder Co.

(These letters appear in left-hand columns, indicate reagent's use.)

Fr Frother
P Promoter
C Collector
Fc Flocculant
Di Dispersant
M Modifier
Fl General flotation
De Depressant
W Wetting agent
A Activator
E Emulsifier

Fr	P	C	Fc	Di	M	Fl	De	W	A	E	Reagent and Mfr.	What It Is	Remarks
Fr	P										Acid Sludge	By-product	Bulk sulphides
Fr			Fc					W			Aciterge OL	Cationic surface active reagent	Nonmetallics in acid circuit-slime flocculator
						Fl					Aconon (T)	Fractionated tall oil, fatty acids	Nonmetallics
						Fl					Aconew Extra (T)	Same as above	Same as above
						Fl					Acosix (T)	Same as above	Same as above
						Fl					Actinol C	Crude tall oil	Nonmetallics
						Fl					Actinol D	Refined tall oil	Nonmetallics
							De				Aero Brand® Cyanide (S)	Crude calcium cyanide	Sulphide depressant
					M		De				Aero Depressant 610 (S)	Organic colloid	Depressant
					M		De				Aero Depressant 615 (S)	Same as above	Depressant for talcose, sercitic gangue
					M		De				Aero Depressant 620 (S)	Same as above	Depressant for talc, etc.
					M		De				Aero Depressant 633 (S)	Same as above	Depressant for carbonaceous gangue
Fr	P										Aerofloat® 15 Promoter (S)	Aryl dithiophosphoric acid	Base metal sulphides, gold, silver ores
Fr	P										Aerofloat 25 Promoter (S)	Same as above	Specially for Ag, Pb, overslimed Cu, Pb and Zn sulphides
Fr	P										Aerofloat 31 Promoter (S)	Same as above	Good galena promoter
Fr	P										Aerofloat 33 Promoter (S)	Same as above	Good for galena, metallic copper
Fr	P										Aerofloat 242 Promoter (S)	Same as above	Water soluble form of Aerofloat 31
	P										Aerofloat 208 Promoter (S)	Alkyl dithiophosphate salt	Gold, silver, copper ores
	P										Aerofloat 211 Promoter (S)	Same as above	Good zinc promoter
	P										Aerofloat 226 Promoter (S)	Same as above	Au, Ag, Zu, Cu ores
	P										Aerofloat 238 Promoter (S)	Same as above	Au, Ag, Cu, Zu sulphides
	P										Aerofloat 243 Promoter (S)	Same as above	Good zinc promoter
	P										Aerofloat 249 Promoter (S)	Same as above	Good copper promoter
	P										Aerofloat® Sodium Promoter (S)	Same as above	Wide usage for zinc, copper sulphides
			Fc								Aerofloc® 548 Reagent (S)	Synthetic polymer	For pH range 4–12
			Fc								Aerofloc 552 Reagent (S)	Same as above	For pH range 4–12
			Fc								Aerofloc 3000 Reagent (S)	Same as above	For highly acid as well as alkaline pulps
Fr											Aerofroth® 65 Frother (S)	Water-soluble synthetic frother	Effective at very small dosages
Fr	P		Fc								Aeromine® 2026 Promoter (S)	Cationic	Silica promoter; clay settling aid
					M		De				Aero Modifier 158 (S)	Synthetic polymer	Slimy gangue depression

*This six page list is based on an earlier one furnished by Denver Equipment Co., as revised by the reagent manufacturers.

Fr	P	C	Fc	Di	M	Fl	De	W	A	E	Reagent and Mfr.	What It Is	Remarks
					M		De				Aero Modifier 162 (S)	Same as 158	Slimy gangue depression
	P										Aero Promoter 404 (S)	Contains mercapto-benzothiazole	Oxidized base metals, sulphides
	P										Aero Promoter 425 (S)	Same as above	Oxidized base metals, sulphides
	P										Aero Promoter 708 (S)	Crude fatty acid	Nonmetallic flotation
	P										Aero Promoter 710 (S)	Na soap of 708	Nonmetallic flotation, tungsten
Fr	P										Aero Promoter 712 (S)	Saponified fatty acid	Water soluble; also good frother
	P										Aero Promoter 801 (S)	Anionic sulfonate	Glass sands, iron, manganese, barite, kyanite
	P										Aero Promoter 824 (S)	Same as above	Same as above
	P										Aero Promoter 825 (S)	Same as above	Same as above
	P										Aero Promoter 827 (S)	Same as above	Same as above
	P										Aero Xanthate 301 (S)	Secondary butyl xanthate	Strong sulphide promoter
	P										Aero Xanthate 303 (S)	K ethyl xanthate	General sulphide promoter
	P										Aero Xanthate 322 (S)	K isopropyl xanthate	Stronger promoter than 303, 325
	P										Aero Xanthate 325 (S)	Na ethyl xanthate	General sulphide promoter
	P										Aero Xanthate 343 (S)	Na isopropyl xanthate	Strong sulphide promoter
	P										Aero Xanthate 350 (S)	K amyl xanthate	Very strong sulphide promoter
	P										Aero Thiocarbanilide 130 (S)	Wettable diphenyl thiourea	Sulphide promoter
								W			Aerosol® OT Surface Active Agent (S)	Di (2-ethylhexyl) sodium sulfosuccinate	Filter aid
								W			Aerosol 18 Surface Active Agent (S)	N-octadecyl disodium sulfosuccinamate	Froth modifier on tungsten
			Fc					W			Aerosol C-61 Surface Active Agent (S)	Cationic	Settling aid for clay, silicates
		C									Alamac 26 (W)	Tallow amine acetate	Feldspar, phosphate and other nonmetallics
		C									Alamac 26D (W)	Distilled tallow amine acetate	Potash and other nonmetallics
		C									Alamac H26D (W)	Distilled hydrogenated tallow amine acetate	Potash and other nonmetallics
		C									Alamine 26 (W)	Tallow amine	Phosphate, feldspar and other nonmetallics
		C									Alamine 26D (W)	Distilled tallow amine	Potash and other nonmetallics
		C									Alamine H26D (W)	Distilled hydrogenated tallow amine	Potash and other nonmetallics
		C									Aliphat 44A (W)	Distilled tall oil fatty acids	Fluorspar, barite, hematite and other nonmetallics
		C									Aliphat 44B (W)	Distilled tall oil fatty acids	Fluorspar, spodumene and other nonmetallics
		C									Aliphat 44D (W)	Distilled tall oil fatty acids	Fluorspar, barite, phosphate, scheelite and other nonmetallics
		C									Aliphat 44E (W)	Distilled tall oil fatty acids	Fluorspar and other nonmetallics
									E		Alkaterges A, E, and T (N)	Cationic oil soluble surface active agents	Nonmetallics
Fr								W	E		Alkaterge C (N)	Non-volatile cationic surface active amine	Nonmetallics
		C									Alpha-Sulfo Palmitic Acid (X)	Sulfonated palmitic acid	Barite, beryl, iron oxide
		C									Alpha-Sulfo Stearic Acid (X)	Sulfonated stearic acid	Barite, beryl, iron oxide
			Fc								Alum (E)	$Al_2(SO_4)_3 \cdot 18H_2O$	Slimes
				Di							Amijel	Form of corn starch	Gangue slimes
Fr	P										Amine 220 (B)	Heptadecyl glyoxalide	Silica and iron oxide from barite
					M						Amono-Phos	Crude mono-ammonium phosphate	
	P										Annite Reagent A	Amine soap	Oxidized minerals
		C									Armac C (X)	Primary coco amine acetate	Hematite, magnetite, ilmenite, scheelite monazite, chromite and gypsum
		C									Armac S (X)	Primary soya amine acetate	Same as Armac T
		C									Armac T (X)	Primary tallow amine acetate	Silica, phosphate, feldspar, mica, spodumene, beryl, clay, potash, heavy minerals from beach sand
		C									Armac TD (X)	Distilled primary tallow amine	Same as Armeen T plus potash
		C									Armeen C (X)	Primary coco amine	Hematite, magnetite, ilmenite, wolframite, scheelite, monazite, chromite, feldspar, mica separation
		C									Armeen HTD (X)	Distilled primary amine of hydrogenated tallow	Nonmetallics, mainly potash

Flotation Reagents *(Continued)*

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E Allied Chemical & Dye Corp.
F Marathon Corp.
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H American Gum Products Co.
J Baker Castor Oil Co.
K Emery Industries Inc.
L Industrial Oil Products Corp.
M E. I. du Pont de Nemours & Co.
N Commercial Solvent Corp.
P Minerec Corp.
Q Dewey & Almy Chemical Co.
R Sharples Chemicals, Inc.
S American Cyanamid Co.
T Newport Industries, Inc.
U Pacific Lumber Co.
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X Armour & Co.
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Fc Flocculant
Di Dispersant
M Modifier
Fl General flotation
De Depressant
W Wetting agent
A Activator
E Emulsifier

Fr	P	C	Fc	Di	M	Fl	De	W	A	E	Reagent and Mfr.	What It Is	Remarks
		C									Armeen S (X)	Primary soya amine	Same as Armeen T
		C									Armeen SD (X)	Distilled primary soya amine	Same as Armeen T plus potash
		C									Armeen T (X)	Primary tallow amine	Silica, phosphate, feldspar, mica, spodumene beryl, clay
		C									Armeen TD (X)	Distilled primary tallow amine	Same as Armac T, good for potash
		C									Armoflote S (X)	Liquid amine	Phosphate, mica
		C	Fc								Arquad 2C (X)	Dicoco-dimethyl ammonium chloride	Silica. Slime flocculation
		C				Fl					Arquad S (X)	Soya-trimethyl ammonium chloride	Collector for silica. Float clays
						Fl					Arquad 2HT (X)	Dioctadecyl dimethyl ammonium chloride	Slime flocculant
					M						Barium Chloride	$BaCl_2$	Quartz
Fr		C									Barrett Flot. Oil No. 4	Coal tar creosote oil	Sulphides
	P				M						Barrett No. 410	Coal tar creosote oil	Sulphides, froth modifier
					M						Barrett No. 634	Coal tar creosote oil	Sulphides, for stiffer froth
	P										Castor Oil Acids 9-11 (J)	Distilled fatty-acids of dehydrated castor oil	Oxides, nonmetallics
	P										Castor Oil Acids 135 (J)	Octadecadienoic acid	Oxides, nonmetallics
				Di	M						Caustic soda	NaOH	Alkalinity regulator
			Fc	Di							Cellulosics CMC (Z)	Sodium carboxy-methyl-celluose, ionic	Gangue slime depressant sulphide flotation
	P		Fc	Di							Cellulosics CMHEC (Z)	Carboxymethyl hydroxyethyl cellulose	Iron ore, nonmetallics
		C							A		Copper Sulphate	$CuSO_4 \cdot 5H_2O$	Sphalerite, arsenopyrite
Fr		C									Creosote Coal Tar		Sulphides, tough froth
Fr		C									Creosote No. 1 Hardwood		Sulphides, gold flotation
Fr	P										Cresylic acid (O) (S)	Alkyl phenols	Lead sulphides
							De				Cyanide	Sodium cyanide	Iron, zinc sulphides
				Di							Daxad No. 23 (Q)	Polymerized sodium salts of substituted benzoic alkyl sulfonic acids	Gangue slimes—pH 7-9.5
							De				Dichromate	$Na_2Cr_2O_7 \cdot 2H_2O$	Depress galena in Cu-Pb-Zn separations
Fr											Dowfroth 250 (Y)	Water soluble synthetic	Selective flotation
		C									Dresinate 7X1, 7V6 (Z)	Sodium soaps of rosin	Iron oxides, nonmetallics
		C									Dresinate 7Y1K (Z)	Potassium soap of rosin	Iron oxides, nonmetallics
		C	Fc								Duomeen S (X)	Diamine from soya	Nonmetallics, flocculation of slimes
		C	Fc								Duomeen T (X)	Diamine from tallow	Nonmetallics, flocculation of slimes
		C									Duponol 100 (M)	Sodium octyl sulphate	Molybdenite
		C									Elastoil LL (L)	Linseed oil by-product	Tungsten, nonmetallics
		C									Emcol X 25	Alkanolamine salt of a sulphated complex alcohol	Also used as emulsion with oleic acid, kerosene
						Fl					Emcol 4150	Fatty acid amine sulphate	Manganese

Fr	P	C	Fc	Di	M	Fl	De	W	A	E	Reagent and Mfr.	What It Is	Remarks
	P	C									Emersol 201 (W)	Oleic acid	Fluorspar, ilmenite and nonmetallics
	P	C									Emersol 300 (K)	Distilled vegetable fatty acid	Fluorspar, oxides, nonmetallics
	P	C									Emfac 1202 (W)	Pelargonic acid	Separates halite from potash
							De				Ethyl Silicate (B)	$(C_2H_5)_4SiO_4$	Gangue slimes in acid, neutral circuits where pH is critical
Fr											Eucalyptus Oil		Used in tropics instead of pine oil
									A		Ferric Sulphate	$Fe_2(SO_4)_3 \cdot nH_2O$	Activates arsenopyrite, tetrahedrite in presence of cyanide, zinc sulphate. Floats minerals from sphalerite
Fr	P	C									Fish Oil, Fatty Acid		Anionic collector
				Di							Flexol Plasticizer TOF (B)	Tri, 2-ethylhexyl phosphate	Blinding agent for slime control
						Fl					Flexricin 9 (J)	Propelene glycolmonoricinoleate	Oxides, nonmetallics
					M	Fl					Fuel Oil		Froth control
			Fc				De				Galactasol (W)	Guar gum	Slime flocculant, depressant
							De				Glue	Organic colloid	Slime regulator
Fr											G N S No. 5 (T)	Pine oil	
			Fc				De				Guartec (W)	Guar gum	Slime flocculant, depressant
				Di			De				Gum Arabic		Gangue slimes
							De				Goulac (H)	Calcium lignin-sulphate	Carbonaceous gangues, calcite, barite from fluorspar
							De				Hydrofluoric Acid (E)	60% HF	Flotation of feldspar from quartz—depresses mica
	P	C									Indusoil (G)	Distilled tall oil	Oxides, nonmetallics
								W			Invadine	Sodium alkylbenzenesulfonate	
							De				Lactic Acid	$C_3H_6O_3$	Mica
									A		Lead Nitrate	$Pb(NO_3)_2$	Stibnite, sodium chloride from potash
					M		De				Lime	Calcium hydroxide	pH modifier, depresses pyrite
			Fc								Lintz Reagent R-52	Surface active agent	
						Fl					Mahogany Sherosope F-445	Sodium salt of petroleum sulfonic acids	Metallic, oxide coppers, carbonaceous impurities from Pb-Zn ores
				Di	M		De				Marasperse CB (F)	Partially desulfonated sodium lignosulfonate	Phosphate, nonmetallics
				Di							Marasperse C (F)	Calcium lignosulfonate	Cement rock, iron ore
				Di							Marasperse N (F)	Sodium lignosulfonate	Phosphate, potash, lithium
Fr											Methyl Amyl Acetate (B)		Brittle froth
Fr											Methyl Amyl Alcohol (B)		Brittle froth
Fr											Methyl Isobutyl Carbinol (B)		Selective flotation of sulphides, nonmetallics
				Di							Metso (V) (E)	Sodium metasilicate pentahydrate, also anhydrous	Gangue dispersant
						Fl					Micate	Soap from tall oil	Nonmetallics
	P										Minerec A (P)	Dixanthogen (diethyl dithiobis thionoformate)	Acid or alkaline circuit, excellent copper reagent
	P										Minerec B (P)	Dixanthogen (diethyl dithiobis thionoformate)	Copper, gold in lime circuit
		C									Minerec 27 (P)	Similar to above	Selective, copper ores
Fr		C						W			Nacconol NR (E)	Sodium alkylated aryl sulfonate	Talc, nonmetallics
					M						Naphtha Solvent	Stoddard's solvent	Ilmenite, rutile, used with fatty acids
Fr	P										Naphthenic Acid D (O)	Petroleum by-product	Potash, barite, magnesite
Fr	P										Naphthenic Acid P (O)	Petroleum by-product	Potash, barite, magnesite
	P										Neo-Fat 8 (Caprylic Acid) (X)	Saturated fatty acid	For halite in potash separations
		C									Neo-Fat 42-06 (X)	Fractionated tall oil	Anionic collector for fluorspar, barite, beryl, magnetite, hematite, calcite, spodumene
		C									Neo-Fat 42-07 (X)	Fractionated tall oil	Fluorspar, barite, beryl, spodumene, ilmenite, hematite and calcite
		C									Neo-Fat 42-12 (X)	Fractionated tall oil, 12% rosin	Same as above
		C									Neo-Fat 94-04 (X)	Refined oleic acid	Same as above

Flotation Reagents *(Continued)*

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Di Dispersant
M Modifier
Fl General flotation
De Depressant
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A Activator
E Emulsifier

Fr	P	C	Fc	Di	M	Fl	De	W	A	E	Reagent and Mfr.	What It Is	Remarks
		C									Neo-Fat 139 (**X**)	Refined cottonseed fatty acid	Same as Neo-Fat 42-06
	P	C									Oleic Acid		Nonmetallics, fluorspar
								W			Oronite Wetting Agent (**D**)	Petroleum by-product	Nonmetallics
	P	C									Orso	Neutral soap	Scheelite, tungsten
Fr					M						Orthotoluidine	Black liquid	Froth modifier
							De				Palconate (**U**)	Sodium salt of phenolic acid	Depresses calcite in flotation of fluorspar and scheelite
							De				Palcotan (**U**)	Sodium salt of sulfonated organic acids	Same as above
Fr					M						Pentasol Frother 26 (**R**)	Amyl alcohol	Froth modifier
Fr											Pentasol Frother 124 (**R**)	Mixed amyl alcohols	
Fr											Pine Oil (**S**)	Terpene alcohols and hydrocarbons	Frother
							De				Potassium Permanganate	$KMnO_4$	Selective sulphides
		C									Primene JM-T (**A**)	Branch-chain, primary aliphatic amine	Nonmetallics
		C									Primene 81-R (**A**)	Same as above	Same as above
							De				Quebracho	70% tannic acid	Calcite in fluorspar, wolframite in sulphides
		C									RADA (**Z**)	Rosin amine D acetate	Silica, silicates—used beneficiating feldspar, phosphate, quartz
	P										Reagent 301 (**S**)	Xanthate, higher petroleum alcohol	Sulphides, oxidized base metals after sulphidizing
	P										Reagent 322 (**S**)	See above	Sulphide minerals
	P										Reagent 325 (**S**)	Xanthate, lower alcohol than 301	Sulphides, bulk flotation
	P										Reagent 343 (**S**)	Similar to 301	All sulphide minerals
	P					Fl					Reagent 404 (**S**)	Mercaptobenzthiazole	Oxidized base metals, float vanadium, auriferous pyrite ores
	P					Fl					Reagent 425 (**S**)		Oxidized copper ores, promoter for malachite, azurite
	P										Reagent 444 (**S**)		Cu, Zn sulphides
				Di							Reagent 610 (**S**)		Gangue dispersant
							De				Reagent 645 (**S**)		Carbonaceous gangue, As, Sb sulphides
	P	C									Reagent 710 (**S**)	Vegetable fatty acid	Phosphate, fluorspar, barite
Fr	P										Reagent 712 (**S**)		Floats middlings
	P										Reagent 801 (**S**)	Petroleum sulfonic acids	Nonmetallics, calcite, barite, tungsten, garnet, iron ores
	P										Reagent 825 (**S**)	Similar to 801	Similar to 801, more selective on some ores
	P	C									Red Oil	Oleic-linoleic acids	Anionic collector
		C									RF-54-38 (**X**)	Liquid amine	Phosphate, mica, silica
	P					Fl					Sapamine (**C**)	Cationic reagent	Promoter floating silica from gypsum. Float iron ores
			Fc								Separan 2610 (**Y**)	Synthetic organic	Increase settling and filtering rate
					M						Soda Ash	Na_2CO_3	Alkalinity regulator
							De				Sodium Bisulphite (**E**)	$Na_2S_2O_5$	Fe, Zn sulphides
							De				Sodium Cyanide (**S**)	NaCN	Sulphide depressant
							De				Sodium Ferrocyanide (**S**)	$Na_4Fe(CN)_6 \cdot 10H_2O$	Sulphides, selective—used to float molybdenite from bulk Cu conc.

Fr	P	C	Fc	Di	M	Fl	De	W	A	E	Reagent and Mfr.	What It Is	Remarks
						Fl					Sodium Fluoride (E)	NaF	Nonmetallics, ilmenite, fluorspar
							De				Sodium Hydrosulphite	$NaHSO_2$	Fe, Zn sulphides
	P										Sodium Oleate	Fatty acid soap	Oxides, nonmetallics
							De				Sodium Silicates (V) (E)		Siliceous gangue minerals, gangue slimes
							De				Sodium Silicofluoride (E)	Na_2SiF_6	Quartz, feldspar in spodumene flotation
							De				Sodium Sulphide	$Na_2S \cdot 9H_2O$	Au, silver sulphides
							De				Sodium Sulphite (E)	Na_2SO_3	Fe, Zn sulphides
				Di			De				Sodium Tetra Pyrophosphate	$Na_4P_2O_7 \cdot 10H_2O$	Depress calcite on magnesite
		C									Sonneborn Reagents 1, 2, 3	Petroleum sulfonates	Phosphate, barite, feldspar, fluorspar, manganese oxides
			Fc				De				Starch		Depress slime on sulphide
							De		A		Sulphuric Acid (E)	H_2SO_4	Reactivate pyrite after depressing with lime, cyanide—depresses quartz
Fr	P										Syntex L	Sulphated monoglyceride of cocoanut oil derivation	Molybdenite
							De				Tannic Acid	Tannin $C_{14}H_{10}O_9$	Calcite
	P	C									Tall Oil	See Indusoil	Nonmetallics
Fr		C						W			Tergitol Anionic No. 4 (B)	Sodium lauryl sulphate	Non-sulphide flotation
Fr		C						W			Tergitol Anionic No. 7 (B)	Surface active wetting agent	Non-sulphide flotation
				Di				W			Tergitol NPX (B)	Nonionic alkyl aryl polyglycol ether	Wetting and dispersing agent
Fr											Terposol No. 3 (Z)	Terpinyl methyl ethers and terpene alcohols	
Fr											Tertiary Amyl Alcohol (R)		
	P										Thiocarbanilide		Pb, Zn, Cu, Ag ores—selective on sulphide
	P										Thiocarbanilide 130		Same as above but more dispersable
			Fc								Tragacine Powdafloc	Starch-base powder	Settlement of slimes
				Di			De				Tri-Sodium Phosphate (B)	$Na_3PO_4 \cdot 12H_2O$	Alkaline detergent
		C									Triton X-400 (A)	Dimethyl cetyl benzyl ammonium chloride	Nonmetallics, cationic
		C									Trostol	Rosin and fatty acids	Nonmetallics
	P										TT Mixture	Dissolve not more than 15% thiocarbanilide in hot orthotoluidine	Pb, Cu, Ag ores
Fr	P										Turkey Red Oil	Sulphated, sulfonated castor oil	Nonmetallics
Fr		C		Di				W			Ultrawet DS	Sodium alkyl aryl sulfonate 85% active	Good frother, collector for talc, steatite
Fr		C		Di				W			Ultrawet 30DS	Aqueous solution of above	Same as above
						Fl					Vapor Oil	Hydrocarbon oil	Molybdenite
							De				Wattle Bark Extract	Tannin similar to Quebracho	Calcite
		C									Xanthate Z-3 (Y)	Potassium ethyl xanthate	Selective flotation of complex sulphides
		C									Xanthate Z-4 (Y)	Sodium ethyl xanthate	Same as Z-3
		C									Xanthate Z-5 (Y)	Potassium sec amyl xanthate	Slow floating, semi-oxidized sulphides
		C									Xanthate Z-6 (Y)	Potassium amyl xanthate	Pyrrhotite, slow floating sulphides
		C									Xanthate Z-8 (Y)	Potassium sec butyl	Tarnished sulphide minerals or metallics
		C									Xanthate Z-9 (Y)	Potassium isopropyl xanthate	Pb-Zn-Fe sulphide ores
		C									Xanthate Z-10 (Y)	K-hexyl xanthate	Slow floating sulphides
		C									Xanthate Z-11 (Y)	Sodium isopropyl xanthate	Pb-Zn and Cu selective flotation
		C									Xanthate Z-12 (Y)	Na-sec butyl	Bulk flotation—sulphides and metallics
Fr											Yarmor F (Z)	Pine oil	Sulphide minerals
							De				Yellow Dextrine	Starch product	Slime depressant on sulphides
							De				Zinc Hydrosulphite		Zn, Fe sulphides
							De				Zinc Sulphate		Pyrite, sphalerite in selective flotation of Pb, Zn, Cu ores

Separating Solids from Liquids

DEWATERING OR THICKENING means that a force must be applied to the pulp. That force may be gravity, gravity and vacuum combined, vacuum, pressure or centrifugal. Gravity is the simplest force, does the least amount of work, is best on large particles and as in the case of the thickener, requires lots of floor space. Initial capital costs can be high, but operating cost will be lower than vacuum or pressure equipment.

Gravity and vacuum combine to do low cost filtering on fast settling solids or material that might blind a vacuum filter. They take up considerable floor space and capital costs are higher than for vacuum drums. Operating costs will be slightly higher than for drum filters.

Vacuum is used to do most of our filtering. Drums and disks handle large tonnages of material every day at low cost. Vacuum filters are fast, varied, efficient and don't have to be expensive.

Pressure units, such as the filter press and pressure-drum filter, do the most complete job of dewatering. They have the disadvantage that they are batch or semi-continuous units.

Centrifugal force can be used to thicken in low cost, small, large capacity cyclones. Centrifugals do a good job of filtering, but they are expensive pieces of equipment to install and operate.

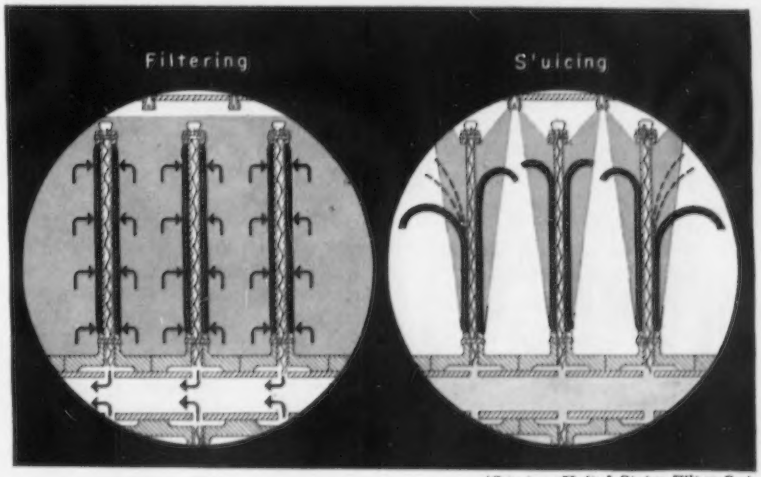
Combinations of several forces seems to be the trend in milling today. A thickener in series with a submerged disk filter, a classifier or a wet cyclone and a final product filter can do a better job on less floor space, in less time and at a lower cost than a series of thickeners and a final filter. In choosing your dewatering units, try for combinations and don't forget to try the chemical dewatering aids (the natural and synthetic flocculants) to cut capital and operating costs.

We put the Auto-Jet on the first page, because it is the latest polishing filter on the market. It is used in the oil and chemical industry, but hasn't been used by the mining industry so far.

AUTO-JET PRECOAT PRESSURE FILTER uses water-jets placed at each leaf to discharge cake as a sludge. This will be to its own disadvantage, if the operator wants a final product cake. This latest entry in polishing filters can be used to advantage to clean process water or clarify pregnant solutions ahead of precipitation.

Any precoat material can be used. It takes from 5 to 10 minutes to put an asbestos coat on the filter leaves. Precoat is fed to the unit as a slurry at 3 to 5 psi pressure. After precoat addition, unit is ready for filter cycle. Pulp is pumped into the tank under pressure until tank pressure hits 30 to 50 psi, where filter cycle is stopped.

Unfiltered pulp in the tank is sent back to pulp head-tank and leaves are rotated on the central shaft. While they rotate, twin water-jets at each leaf peel off the cake and precoat. This sludge falls into the V-shaped sludge compartment, then passes out of the tank. Sluicing cycle takes from 3 to 5 minutes, then precoat cycle can be repeated.



(Courtesy United States Filter Co.)

So far this unit has found water-cleaning jobs in the oil, chemical, food and pharmaceutical industries. One sugar refiner in California, using five Auto-Jets (2,500-sq ft cloth) as a replacement for 11 plate-and-frame filters (6,300-sq ft cloth), cut his operating cost on the polishing step by $19,000 a year. Auto Jet is made by United States Filter Co.

A 500-sq ft model will hold 52-cu ft sludge. It can be had in sizes up to 1,000-sq ft cloth area.

(*Continued on next page*)

DEWATERING PADS represent the simplest and cheapest way to dewater pulp. Just throw it on a pad and let it drain. Pad can be a concrete slope, boards, canvas or a bed of sand.

Simple dewatering pads are being used on mineral concentrates such as spodumene, graphite, sand and gravel, coal, lead and zinc.

Disadvantages are that fines may be lost, material must be reclaimed from the pads by hand, and that amount of moisture removed will depend on temperature and drying time allowed. This wouldn't work in cold climates.

Also, attempts have been made to assist the dewatering step by delivering pulp to filters through a canvas launder. On coarse feed the canvas doesn't last long and maintenance problems abound.

BED OR SAND FILTERS can operate on gravity or positive pressure if the unit is enclosed. Filter media can be layers of graded gravel and sand. Put the finest sizes at the bottom of the tank.

If caustic soda is being filtered, use coal or coke for bed material instead of sand and gravel.

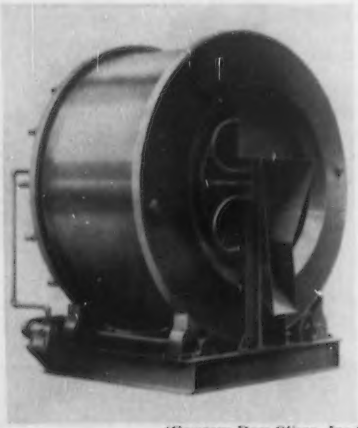
This unit is usually allowed to run until filtration slows down, then bed must be cleaned with compressed air or up-current of water. If a rake is installed at top layer of sand, filter will not plug so soon.

This filter is used to treat process water. Clarity can be improved by adding ferrous or aluminum sulphate to feed water. This will precipitate some hydroxide which will form a fine screen for small particles on top of the gravel and sand.

WET SCREEN costs about 2c a ton to run. It works best in 4- to 40-mesh range, but will work on feed down to 200 mesh. Finer meshes cost too much money. Wet screen handles large tonnages of iron ore, coal, manganese, phosphate, sand and gravel. They treat from ¼ to 2½ tph per sq ft cloth area, depending on mesh of grind.

With 4 mesh feed and 50% open wire, screens dewater down to 3 to 10% moisture. You can buy screens in single, double or triple deck in sizes up to 72x288 in. Wetting agents added to pulp will help cut down moisture content.

Screen wire can be triangular, semi-rectangular or wedge shaped. For easier operation and wear-life, wedge wire is best. Punched plates can be used instead of wire.

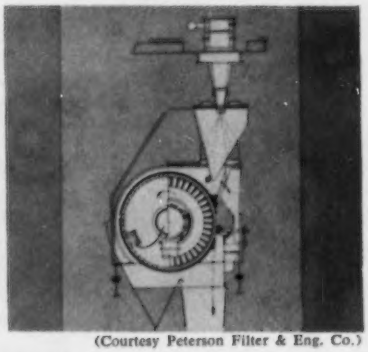


(Courtesy Dorr-Oliver, Inc.)

DORRCO INTERNAL drum filter has filter cloth on inside of the drum, works as its own well. This filter will treat pulps with lots of fines, provided there is enough coarse present to make the gravity cake. Coarse material drops onto cloth in the well and forms coarse cake. Vacuum pulls this coarse cake to cloth and then pulls fines onto first cake. It works well on pulps that tend to blind.

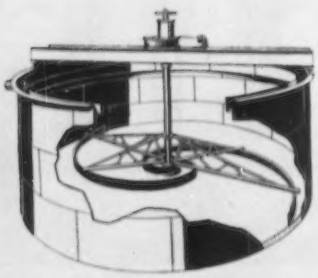
Cake discharges at inside top of drum and leaves filter by a shute. Blow-back discharges cake. Dorrco has one disadvantage—cake that tends to discharge ahead of time misses the shute and falls back into pulp. This lumpy cake causes more cake to discharge prematurely, cutting the unit's capacity.

Internal filter dewaters sulphides, magnetite, tungsten, tin and graphite. It should be considered when pulp contains much fines. Sizes range from 18- to 783-sq ft cloth area.



(Courtesy Peterson Filter & Eng. Co.)

TOP-FEED drum filter delivers pulp to drum from surge bin at top of drum. Overload shunts back to slurry pump. Top feed will handle some fines, but no more than any other drum. Largest size holds 350-sq ft cloth.



THICKENERS AND CLARIFIERS seldom produce absolute separation of solids from liquid. However, with flocculants added, near perfect overflows occur. They handle large volumes of pulp at 1 to 5c per ton cost. With rake set at 10 minutes per revolution, a 50-ft unit draws 3 hp.

Construction cost of 50-ft diameter concrete unit averages about $10 per sq ft settling area. Steel tanks are a bit cheaper, but maintenance costs over the years may wipe out that advantage.

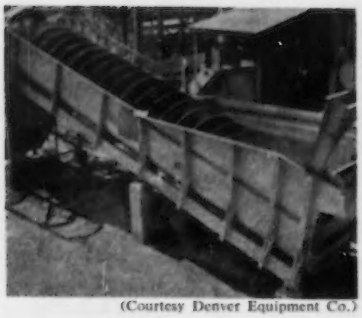
Tanks can be wood, concrete, steel, tile, or even a hole in the ground. Use spiral-rake for fast unloading on solids that tend to pack down or when you want maximum possible underflow density.

Try the cut-flight rake if you need a longer retention time or want deep pulp zone. Large units need a combination of spiral-rake and cut-flight. Pickets on the rakes will give slightly high underflow density.

Torque recorders, motorized lifting devices and automatic rake raising aid are available. Auto-rise devise keeps the unskillful from making the center post look like a coal auger, lifting the whole rake as pulp zone gets too heavy.

Thickeners work best on pulp in the 43- to 150-micron range. They are used to treat almost every known mineral. A 150-ft diameter unit will handle 100 tons minus 150 mesh iron ore per hour, with 12% solids feed and underflow at 33% solids. One phosphate operator has a 325-ft unit in a 750-ft diameter well, treats 15,000 gpm, 2% solids phosphate tailings with underflow set at 14% solids.

Thickeners take up lots of floor space and have rather large initial cost. They are available in sizes up to 325-ft diameter. (Drawing courtesy Hardinge Co.)



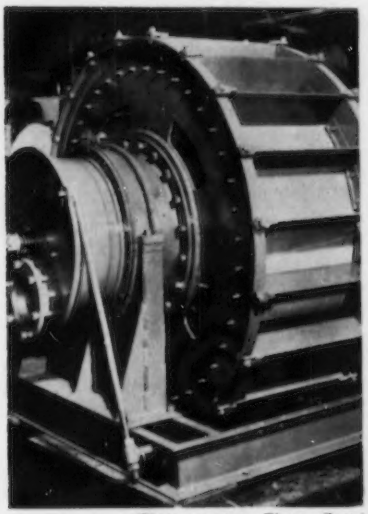
(Courtesy Denver Equipment Co.)

SPIRAL CLASSIFIERS will dewater magnetite, ferrosilicon, pyrrhotite, sand and gravel, salt, potash, jig and table concentrates. Classifiers take surge loads and are easy to operate. They can't treat fines or slimes. They come with 12- to 90-in. diameter spirals.

TRAVELLING-BELT filters use gravity and only work on pulp that will dewater in 15 to 60 seconds. Effective filter area is only 45%. They cost more than a drum, take up more space and have higher maintenance costs. Biggest unit has about 150-sq ft cloth area.

(Courtesy Dorr-Oliver, Inc.)

SCROLL-DISCHARGE rotary horizontal filter combines gravity and vacuum. It works best on heavy, coarse material or feed that tends to blind filter cloth. It keeps filtrate and wash water separate. It costs more than a drum, takes up more floor space and costs more to maintain. Sizes available from 3.5- to 516-sq ft cloth area.



(Photo courtesy Eimco Corp.)

HOPPER-DEWATERING filter is vacuum unit. Feed comes to drum at the top, but no surge bin is present. Lack of surge bin puts hopper-dewatering to a disadvantage, since surge overload will slop pulp into cake hopper below.

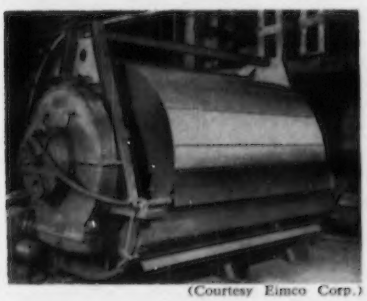
It works best on fast-settling, coarse, crystalline solids in 10- to 200-mesh range. Pulp must dewater in 20 seconds or less. Some cake washing can be done.

It works fine on sand, salt, potash, phosphate, nickel, iron, ilmenite and mica. Cake discharges by gravity into cake hopper. Screw conveyor or star valve unloads hopper. This filter can be converted into drier, by enclosing unit and providing source of heat.

It comes in sizes from 3- to 6-ft diameter, with 9- to 575-sq ft cloth.

(Courtesy Eimco Corp.)

TILTING-PAN rotary horizontal filter has a series of filter pans on a turntable. Pans load, dewater, wash and unload in turn. Pan inverts to discharge cake. Unit keeps filtrate separate from washes. It is more expensive than scroll, takes up more floor space than drum and is more expensive to maintain than scroll. Available with 27- to 516-sq ft cloth.



(Courtesy Eimco Corp.)

SINGLE - COMPARTMENT DRUM filter is very low cost installed. It has very simple construction, using a scraper-knife to discharge cake. Main disadvantage is that a tear in the cloth puts the whole filter out of action. Sizes go up to 905-sq ft cloth.

MULTIPLE - COMPARTMENT DRUM gets away from the disadvantage of single compartment unit. Each segment works independently of the others. Cloth damage only affects one section, which can be shut off. Discharge can be by blow-back or scraper and blow-back. Sizes up to 905 sq ft. Drums with internal magnets can dewater magnetic pulp better than either alone.

STRING - DISCHARGE DRUM vacuum-filter uses a layer of string, instead of blow-back or scraper, to remove cake from segmented drum. No bands needed to hold and protect cloth. Cloth lasts longer than on other drums, but the string can break. Won't work unless the string can pick off the cake. It comes in sizes same as above.

These three drum filters will handle any material that forms a cake and can be picked up by the drum.

PRECOAT SEMI-CONTINUOUS DRUM vacuum-filter will treat thinner pulp than any other drum. Operation starts by putting a 2-in. layer of precoat material on the cloth. Then pulp dewatering starts. Scraper-knife discharges cake and a thin layer of precoat material. Knife has almost razor edge and can be adjusted. When most of the precoat layer has been removed, filter cycle must stop until a new precoat can be applied.

Uranium producers use precoats to filter thickener overflow. Precoats will not blind. They will handle any kind of pulp. Sizes up to 905-sq ft cloth available.

(Courtesy Elmco Corp.)

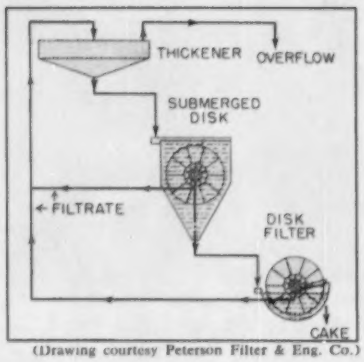
DISK vacuum-filter has many advantages. It has largest capacity and largest cloth area of any filter. More than one pulp can be filtered at same time. Disks are segmented. Cloth damage only affects one segment on each disk. Cake cannot be washed. Cake must discharge by blow-back. Eight 6-ft diameter disks, totalling 720-sq ft cloth, drawing 3 hp, can filter 180 tons lead-zinc concentrate in 24 hours. Sizes up to 2,400-sq ft cloth possible.

SUBMERGING A DISK FILTER converts it into a vacuum filter-thickener. This idea has taken hold in the uranium country, where submerged disks substitute for larger, bulkier and less efficient thickeners.

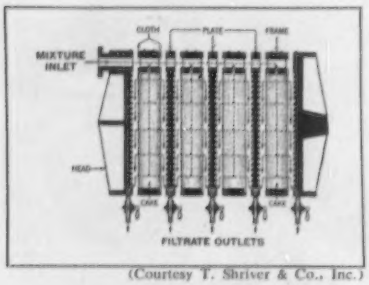
Cake discharged by blow-back, falls back into pulp and settles to bottom of tank. Discharge from tank is controlled by diaphragm pump. Underflow density as high as 70% is possible.

As each segment begins its suction cycle, first filtrate comes off cloudy. If this material is important, special valve arrangement will return this first gush to the well.

Submerged units should be placed in line between a thickener and final product filter. Sizes up to 2,400-sq ft cloth.



(Drawing courtesy Peterson Filter & Eng. Co.)



(Courtesy T. Shriver & Co., Inc.)

PLATE-AND-FRAME FILTER PRESS is a skeleton of individual frames, alternating with filter plates, held together by a screw or by hydraulic pressure. Unit dewaters under pressure up to 250 psi, forcing filtrate through cloth or screen cover on plates, leaving cake behind. As many as 50 frames can go on a press.

Filter rate is governed by the pressure applied, total solids, temperature, viscosity and particle size. Cake can be washed. Cake can be dried by heating the unit after washing step ends. Add heating or cooling coils if temperature control is important.

Two types can be had. One is the recessed-plate and the other is the plate-and-frame. As a rule, plate-and-frame units have lower operating costs and better cloth-life.

Frames have either side or corner feed. Side feed is best.

Plates can be made of almost any type metal or wood. Pyramid-cut on plate surface permits fast drainage. Perforated plates or heavy screens replace ordinary plates on high pressure jobs. Use smaller frames for high pressure feed.

Filter cloth may be any of several types, listed in order of decreasing cost and decreasing resistance to wear: stainless steel, monel, plain or galvanized steel, silicon bronze, phosphor bronze, brass, aluminum and copper. Tougher and more costly wire may often be cheaper in the long run. It will cut down-time and labor costs. These same screen cloth materials can be used on wet screens as well.

On plate-and-frame units, cloth is stretched over cut-plate and held in place by closing screw pressure.

At the end of filter and wash cycle, unit must be opened so that cake can be scraped or brushed off cloth. How often press has to be opened will be determined by total solids in feed. This batch filter is made with up to 28.4-sq ft cloth per plate; or about 1,420-sq ft on 50-frame model.

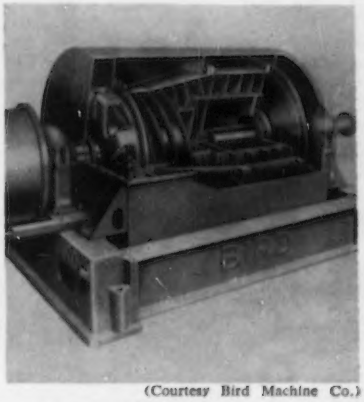
WET CYCLONE can be used as a thickener—if there are no fines present or if the fines have no value. Where a choice between cyclone and mechanical classifier exists, the cyclone will be cheaper to install. Including slurry pumps, cyclones can be expensive to operate and maintain.

Repairs and operating costs on pumps and abrasion damage to cyclone, all combine to make cyclone expensive to operate. Kellogg Krebs, president, Equipment Engineers, Inc., takes exception to this. ". . . We've supplied cyclones for several hundred jobs and capital costs including pumps range from 20 to 50% of a classifier. In precision desliming, cyclone has truly obsoleted the classifier and hydroseparator . . . I do take exception to Fred DeVaney's remark, where he refers to NiHard becoming the almost universal lining and rubber lining of any type not standing abuse. This is true of rubber-lined pumps on tough, coarse jobs, but not a cyclone . . . no one has ever yet had to replace the body liners of a Krebs cyclone."

Cyclones save space, have high efficiency, high capacity and low initial cost. They can be installed in any position without effecting separation. They deslime, thicken and classify; either alone or in conjunction with one or more classifiers.

Size of cyclone depends on separation rather than on desired capacity. A 24-in. cyclone will handle 1,000 gpm at 20 psi on 100 to 150 mesh feed. Cyclones come in sizes from 10mm to 24-in. diameter.

(Photo courtesy Dorr-Oliver, Inc.)

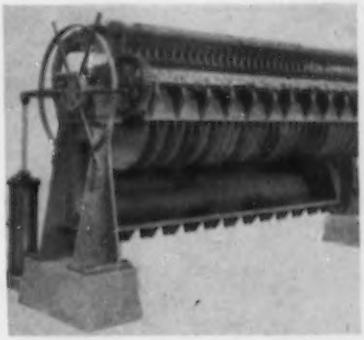


(Courtesy Bird Machine Co.)

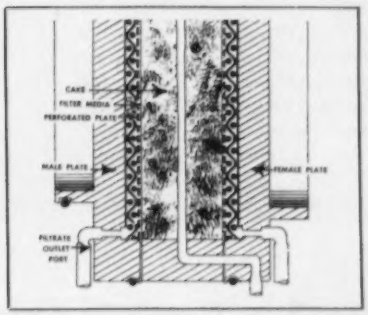
CENTRIFUGALS should be considered when pulp is tough to pick up on vacuum filter or when pulp density goes over 20% solids. Centrifugals can be economic if pulp solids exceed 50 lb per sq ft cloth.

Centrifugals can't be used unless cake is firm enough to be pushed out of the basket by the plow. No filter media needed, but keep a spare plow in good repair on hand and install it on a running hour schedule. Hard-facing running-edge of plow will make it last longer on abrasive feed. A shear-pin protects bowl against overload. Pin gives way when total water and solids reaches predetermined amp-hour load. It takes about 3 minutes to replace broken pin.

Solids recovery from centrifugals on material all minus 65 mesh and mostly minus 200 mesh can be as high as 99.6%. Cake can be washed. Largest unit available will dewater 40 cfm or 600 gpm. It will cost $35,000 to $50,000, in steel or stainless.



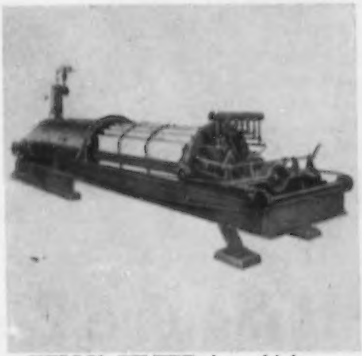
SWEETLAND PRESSURE-FILTER operates at low pressure. Filtrate quality at each plate can be seen through sight glasses. Cake can be dumped with body open or flushed out with body closed. Largest unit has 1,000-sq ft cloth.



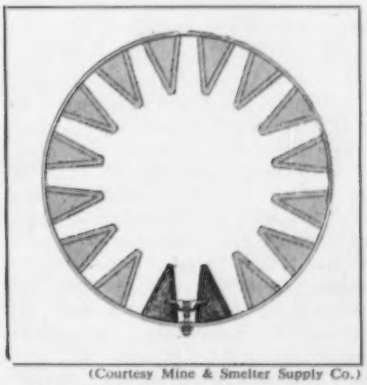
EIMCO-BURWELL SEMI-CONTINUOUS filter produces the driest cake, washes better, cuts down-time and holds more cake per sq ft than any filter press. It opens and closes faster than the others. Unit is a series of frames between pairs of filter surfaces. Air pressure keeps frames and chambers in place. Feed enters chamber formed by frame and two filter chambers, forms cake on each cloth face. When chamber fills with cake, feed shuts off and air pressure drives out filtrate.

Cake can be washed. Blow-back pushes cake away from cloth, then vacuum comes on and pulls chambers and frames apart. Cake-filled frames lift out of the unit and second set of frames drops in place. While cake is being brushed out of one set of frames, the second set is in place and treating pulp.

Eimco-Burwell filter holds up to 30 frames. Filter frames can be 1- to 3-in. thick. A 30-frame unit with 3-in. frames can hold 27.6-cu ft cake on 221.1-sq ft cloth per filter frame.



KELLY FILTER is a high pressure batch filter with filter leaves set the length of tank. Cake is discharged after pulling filter leaves. It is available in sizes up to 1,300-sq ft cloth.



(Courtesy Mine & Smelter Supply Co.)

BURT-BATCH FILTER is probably the least known polishing filter. It was designed for gold-cyanide slimes. Sullivan Mining Co. uses this type. They are 40-ft long, hollow steel chambers. Cloth covered filter boards, triangular in shape, run the length of the tank. Boards are grooved to speed up filter rate. One side of triangle fits against inside of chamber and is held in place by bolts.

Sullivan's tanks hold 4,144 gal pulp. During filter cycle, the chamber rotates on trunions; this speeds up filter rate by providing fresh surface on boards. At start of cycle, air pressure is set at 40 psi. When pressure drops to 5 psi, filtration is complete.

Cake is discharged from chamber by forming slurry with water and draining tank. One man can operate up to 5 filters—if the cycle time is not less than 3 hours. Boards at Sullivan are re-covered with canvas every 18 months.

(Courtesy Dings Magnetic Separator Co.)

MAGNETIC SEPARATORS will dewater magnetite or any other magnetic pulp. They concentrate as well as dewater.

I. Who is Doing What in Uranium Milling,

Location	Uranium mill Operator	Date of initial uranium concentrate shipment to AEC, Grand Junction	Initial mill flowsheet for uranium recovery	Present flowsheet for uranium recovery
Naturita, Colo.	Vanadium Corp. of America	October 1947	Flowsheet No. 5	Flowsheet No. 5
Durango, Colo.	Vanadium Corp. of America	August 1949	Flowsheet No. 5	Flowsheet No. 5
Rifle, Colo.	Union Carbide Nuclear Co.[1]	December 1947	Flowsheet No. 4 Circuit A	Flowsheet No. 4 Circuit A
Uravan, Colo.	Union Carbide Nuclear Co.[1]	March 1950	Flowsheet No. 4 Circuit A	Flowsheet No. 4 Circuit B
Monticello, Utah	Galigher Co. for Atomic Energy Commission	January 1950	Flowsheet No. 5 without scavenger leach	Flowsheet No. 8 & Flowsheet No. 10
Grand Junction, Colo.	Climax Uranium Co.	June 1951	Flowsheet No. 6	Flowsheet No. 6
Salt Lake City, Utah	Vitro Uranium Co.[2]	October 1951	Flowsheet No. 7	Flowsheet No. 7
Bluewater, N. M.	Anaconda Co.[3]	November 1953	Flowsheet No. 8	Flowsheet No. 8 & Flowsheet No. 10
Shiprock, N. M.	Kerr-McGee Oil Industries, Inc.	January 1955	Flowsheet No. 9	Flowsheet No. 9
Moab, Utah	Uranium Reduction Co.	Summer 1956[4]	Flowsheet No. 10	
Edgemont, S. D.	Mines Development Co.	Summer 1956[4]	Flowsheet No. 10	
Tuba City, Ariz.	Rare Metals, Inc.	Summer 1956[4]	Flowsheet No. 10	
Maybell, Colo.	Trace Elements, Inc.	Fall 1956[4]	Acid leach—neutralization of clear pregnant liquor	
La Sal, Utah	Continental Uranium Co.	Spring 1957[4]	Acid leach—countercurrent decantation—IX columns	

NOTES: [1] Formerly United States Vanadium Co. [2] Formerly Vitro Chemical Co. [3] Formerly Anaconda Copper Mining Co. [4] Estimate. [5] Capacity increases are only approximate.

If You're Planning Uranium Extraction,

Distinct Pilot Plant Operations

From 1948 through 1955, four distinct pilot operations, not associated with an established milling operation, have delivered uranium concentrate to the AEC.

1. The first was VCA's pilot operation at Hite (White Canyon), Utah, which mainly processed ore from the Happy Jack mine. An acid leach was used, and the leach liquors were neutralized with excessive sodium carbonate. The resulting alumina sludge was removed, and the liquor containing the uranium was then acidified to destroy the carbonate; and with the addition of a small amount of caustic, the uranium was precipitated as sodium diuranate. This plant averaged around 20 tpd from August 1949, to December 1953, when it was shut down and later dismantled.

2. Between September 1953, and August 1954, Mining Research Corp. delivered small amounts of uranium concentrate produced in connection with its operations near Edgemont, S. D. This concentrate resulted from neutralizing the acid leach liquors from both "in situ" leaching experiments and percolation leaching of mined ore.

3. During the summer of 1955, Trace Elements Corp. operated a pilot plant at Maybell, Colo., in order to obtain acid leaching and material handling data for a milling operation on ores which it controlled in the area. Uranium concentrates resulting from neutralizing the acid leach liquors were delivered to the AEC.

4. In the spring of 1952, American Cyanamid Co., under a research contract with the AEC, started operation of a 6-tpd pilot plant which it had constructed on the Grand Junction Operations Office compound. Subsequent research developments and need for a central facility for piloting new processes and amenability testing of the diverse uranium ore types for AEC information, led to the construction of a large and versatile pilot plant facility on the Grand Junction AEC compound, which, in conjunction with the AEC's Raw Materials Development Laboratory at Winchester, Mass., is now operated by National Lead Co. under a research contract. Although not limited to three processes, the pilot plant is capable of and is generally operating three separate circuits at a time for process development and amenability studies, which total a daily ore feed between 20 and 30 tons. Uranium concentrates from the Grand Junction pilot plant operations are an added increment to the Colorado Plateau production.

January 1956

Remarks[5]
Present capacity is 300% of initial.
Present capacity is 250% of initial.
Present capacity is 200% of initial. Minor circuit modifications have been made to facilitate plant operation.
Present capacity is 200% of initial, with construction being completed to increase this to 400% of initial.
Present capacity is 500% of initial. Flowsheet No. 8 started in August 1955. Flowsheet No. 10 started in November 1955.
Present capacity is 300% of initial. Acid leaching changed from percolation to countercurrent filtration in Spring 1955.
Present capacity is 300% of initial.
Present capacity is around 1,000% of initial. Flowsheet No. 10 started in December 1955. Capacity of Flowsheet No. 8 has been tripled.
Present capacity is around 200% of initial.
Plant under construction.
Plant under construction.
Plant under construction.
Plant to be constructed. Plans to install eventually IX columns for uranium recovery.
Plant to be constructed.

WILLIAM L. LENNEMANN
U. S. Atomic Energy Commission
Grand Junction, Colo.

Bill Lennemann describes himself as a "maverick chemical engineer" having received his basic degree from the University of Nebraska in January 1943 and a Master's degree from Illinois Institute of Technology in 1950. Between those times he spent three years in the army and worked for Jefferson Chemical Co. at Port Arthur, Tex., and for Climax Molybdenum with its metallurgical division at Golden, Colo.

Mr. Lennemann joined the processing division of AEC's Grand Junction Operations Office after working for two years for Climax Uranium at its Grand Junction mill. His present position with the processing division is metallurgical advisor.

A previous Lennemann article, "How To Extract Uranium From Ores," appearing in the September 1954 issue of *E&MJ*, was a comprehensive discussion of the problems of getting uranium into solution. The thorough and highly readable article below takes up where the earlier one left off and offers a complete survey of the methods currently used to extract uranium from solution as a concentrate.

Take A Look at Today's Flowsheets

ANALYSIS OF URANIUM METALLURGY reveals numerous and diverse approaches to the problem of extracting a suitable concentrate from a wide variety of ores. One of the easiest ways to understand the fine points of the art as it is practiced today, and as it may be practiced tomorrow, is to examine the development of present flowsheets that summarize uranium milling operations today.

This summary includes only those uranium milling operations in the western United States and from which the Grand Junction Operations Office, AEC, has received uranium concentrates. It does not include uranium production from processing phosphate rock, nor does the topic include pilot operations which are considered to be those operations of less than 50 tpd milling capacity.

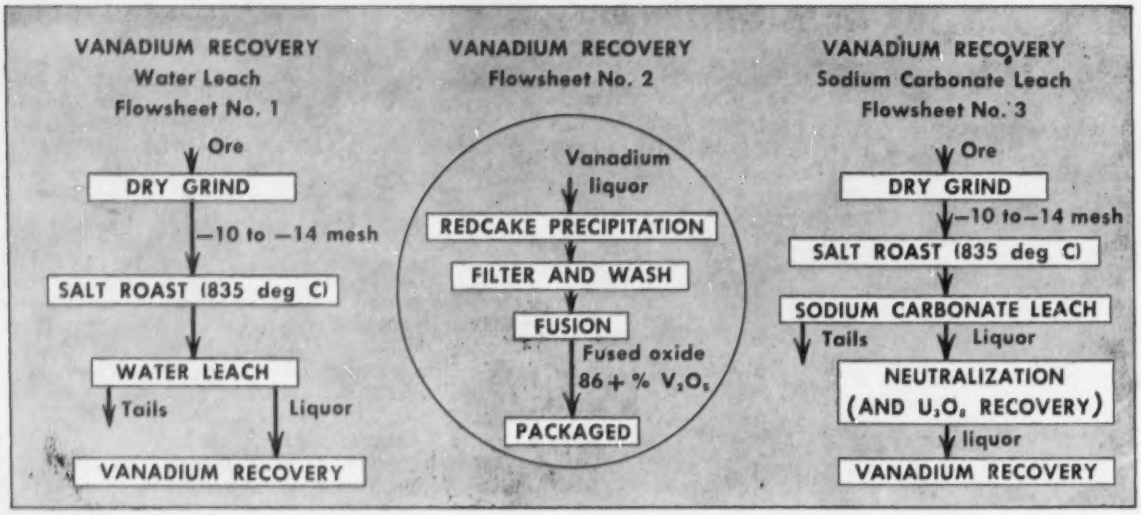
Since the inception of the Atomic Energy Commission's program in 1948 for purchasing and encouraging the production of domestic uranium concentrates, nine uranium mills have come into production in or about the geographical region known as the Colorado Plateau, three new mills are in various stages of construction, and two others are soon to be constructed. The mills are listed in the table above. Many other organizations are proposing the construction and operation of additional milling facilities.

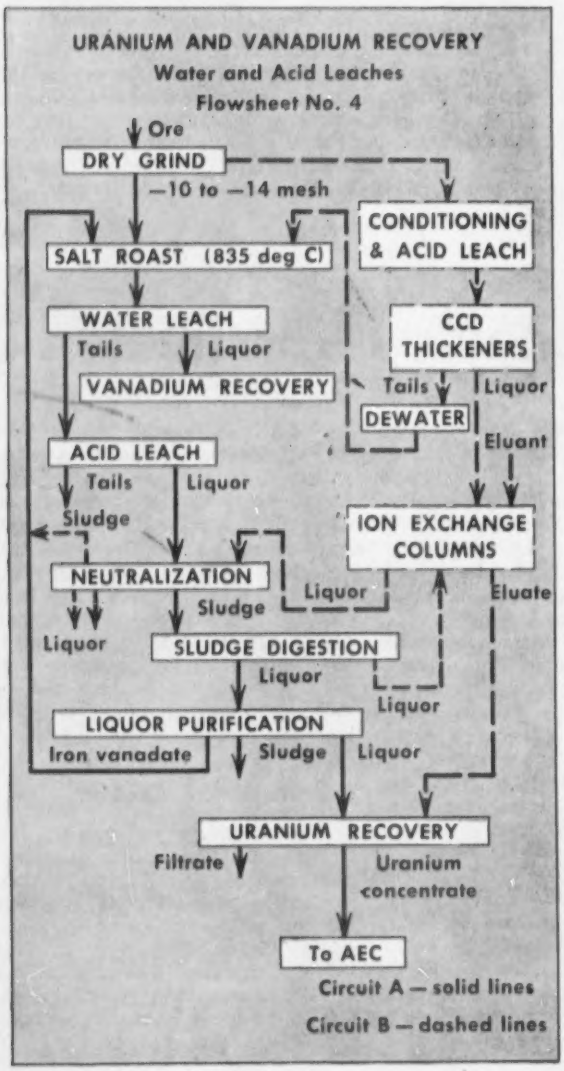
Milling uranium ores and the production of suitable uranium concentrates is primarily a hydrometallurgical process; and unless something revolutionary develops, it will continue to be. Uranium values are solubilized by either of two types of lixiviants: (1) 3% to 10% sodium carbonate solutions which should contain enough bicarbonate to insure the absence of reactive hydroxyl ions, and (2) acid solutions which may contain from 0.5% to several per cent free acid. The pH should generally be maintained below 1.5 for good acid leaching, although in some ores, uranium can be leached at a higher pH.

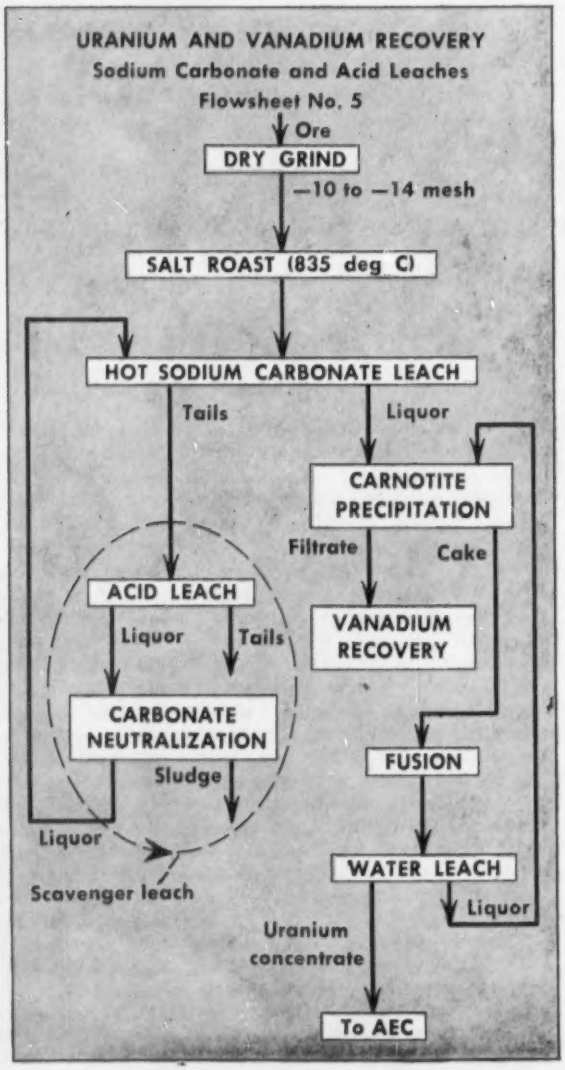
In following the history of these two lixiviants through the uranium milling circuits, one must remember that the initial uranium recovery mills of the western United States processed carnotite and roscoelite ores, which had been and were being mined and processed for vanadium recovery. At that time no one anticipated that large deposits of uraniferous ore containing little or no vanadium would be found. Uranium concentrate production started as a by-product of the vanadium mills, and therein its full scale metallurgy was first developed.

Vanadium Recovery

In the 25 years prior to 1948, the flowsheet used for vanadium recovery from the carnotite and roscoelite ores had settled on a salt roast in which the ores were dry ground to about minus 14 mesh, mixed with salt, 6 to 7% by weight, and roasted at 825 to 850 deg C in multiple hearth roasters for an optimum period. Resultant calcine was quenched in water or


VANADIUM RECOVERY
Water Leach
Flowsheet No. 1
Ore
DRY GRIND
—10 to —14 mesh
SALT ROAST (835 deg C)
WATER LEACH
Tails
Liquor
VANADIUM RECOVERY
VANADIUM RECOVERY
Flowsheet No. 2
Vanadium liquor
REDCAKE PRECIPITATION
FILTER AND WASH
FUSION
Fused oxide
86 + % V2O5
PACKAGED
VANADIUM RECOVERY
Sodium Carbonate Leach
Flowsheet No. 3
Ore
DRY GRIND
—10 to —14 mesh
SALT ROAST (835 deg C)
SODIUM CARBONATE LEACH
Tails
Liquor
NEUTRALIZATION
(AND U3O8 RECOVERY)
liquor
VANADIUM RECOVERY


URANIUM AND VANADIUM RECOVERY
Water and Acid Leaches
Flowsheet No. 4
Ore
DRY GRIND
—10 to —14 mesh
CONDITIONING & ACID LEACH
SALT ROAST (835 deg C)
WATER LEACH
Tails
Liquor
VANADIUM RECOVERY
CCD THICKENERS
Tails
Liquor
DEWATER
Eluant
ACID LEACH
Tails
Liquor
Sludge
ION EXCHANGE COLUMNS
NEUTRALIZATION
Liquor
Sludge
Eluate
Liquor
SLUDGE DIGESTION
Liquor
Liquor
LIQUOR PURIFICATION
Iron vanadate
Sludge
Liquor
URANIUM RECOVERY
Filtrate
Uranium concentrate
To AEC
Circuit A — solid lines
Circuit B — dashed lines


URANIUM AND VANADIUM RECOVERY
Sodium Carbonate and Acid Leaches
Flowsheet No. 5
Ore
DRY GRIND
—10 to —14 mesh
SALT ROAST (835 deg C)
HOT SODIUM CARBONATE LEACH
Tails
Liquor
CARNOTITE PRECIPITATION
Filtrate
Cake
ACID LEACH
Liquor
Tails
VANADIUM RECOVERY
CARBONATE NEUTRALIZATION
Sludge
FUSION
Liquor
Scavenger leach
WATER LEACH
Liquor
Uranium concentrate
To AEC

sodium carbonate solutions to extract the vanadium which had been converted to a soluble sodium vanadate by the salt roast.

Vanadium was recovered from the leach solution by adjusting the solution pH to 3 with acid, and heating and stirring, which precipitated and flocculated a sodium polyvanadate, commonly called "red cake." The red cake was removed by filtration, washed and fused with a direct flame to give the fused vanadium pentoxide containing over 86% V_2O_5. These processes are illustrated in Flowsheets 1, 2 and 3.

Initial Uranium Recovery

When the AEC negotiated contracts with the vanadium mills for by-product uranium concentrate, it became necessary for the vanadium mills to expand their flowsheets for uranium recovery. The chemistry and metallurgy for uranium recovery had been rather fully investigated as far back as the period of the radium boom days between 1900 and 1920, but had never been applied on a large milling scale.

Although, within limitations, a salt roast does not substantially affect the solubility of uranium, it does give a porous, filterable and easily leached calcine, so additional leaching facilities and techniques for producing a good grade of uranium concentrate were incorporated in the mills as illustrated in Circuit A of Flowsheet No. 4 and Flowsheet No. 5.

Pioneering the uranium recovery operations in the vanadium mills were United States Vanadium Co. (now Union Carbide Nuclear Co.) and Vanadium Corporation of America. United States Vanadium Co. settled on the water leach for vanadium recovery followed by an acid leach and liquor purification for uranium recovery in its Rifle and Uravan mills, while the Vanadium Corporation of America favored the carbonate leach-fusion flowsheet for its mills at Naturita and Durango.

In circuits which utilize a water leach for vanadium dissolution, water leached tails are dewatered and given an acid leach which dissolves 90 to 95% of the uranium along with 50% or more of the remaining vanadium and certain amounts of alumina, silica, iron and other miscellaneous acid soluble components of the calcine. This impure solution is next neutralized with caustic or ammonia to a pH of approximately 4.5 which precipitates a so-called "green sludge." The green sludge consists of the iron, alumina, silica and other acid soluble hydrates which are dissolved in the acid leach, and also contains all of the uranium and vanadium. From 50 to 100 lb of green sludge per ton of ore treated is thus obtained. This sludge is then filtered from the solution and redissolved by heating with sulphuric acid and an oxidizer such as sodium chlorate.

This step of sludge formation and redissolving is essentially a dewatering and concentrating operation which decreases the amount of solution necessary to handle. After the green sludge is redissolved, the acid liquor is again neutralized with a base, and using pH control under proper conditions, vanadium is precipitated and removed as iron vanadate at a pH range of 2.5 to 3. The iron vanadate is returned to the salt roasting operation.

After vanadium removal, the liquor is taken to a pH of about 9 by neutralizing with sodium carbonate; and alumina, silica, iron and other miscellaneous hydrates again precipitate as an "alumina sludge," with the uranium remaining in solution as the uranyl tricarbonate complex. The alumina sludge is filtered from the solution and washed to remove as much of the uranium-containing liquor as possible with bayonet-type filters.

The filtrate, a sodium carbonate solution, contains little other than the uranyl tricarbonate complex. This solution is acidified and boiled to drive off the CO_2 which breaks up the complex; and with the addition of a base, the uranium is quantitatively precipitated as a relatively pure salt.

In the method just outlined, a uranium concentrate is obtained by the process of preparing a solution which contains little other than uranium. The method has its advantages but involves considerable plant operation, many steps and close control. It also involves a high chemical consumption because the pH scale is traversed several times.

In circuits which utilize a sodium carbonate leach for vanadium dissolution, the calcine is quenched in a sodium carbonate solution which quickly dissolves 75 to 80% of the vanadium and on longer contact time in hot solution readily dissolves 75 to 85% of the uranium. One advantage of the sodium carbonate solvent is that it is almost selective for uranium and vanadium, and dissolves a minimum amount of other constituents in the calcine. Uranium is recovered from the solution as a synthetic carnotite precipitate (sodium uranyl vanadate) by adjusting pH of carbonate liquor to around 6.0 with H_2SO_4 and boiling to remove the CO_2. This precipitates synthetic carnotite which is removed by filtration. Vanadium in excess of the stoichiometric amount required to precipitate the uranium remains in the filtrate and is recovered by classic red cake precipitation.

In addition to containing around 20% vanadium, synthetic carnotite also contains amounts of other impurities; and the cake is given a reducing fusion using a formulated flux consisting of salt, soda ash and sawdust or fuel oil. This fusion forms the water-insoluble black uranium oxide and water-soluble sodium salts of the vanadium and the other amphoteric impurities. The melt is allowed to cool and then is water-leached, which leaves the concentrate, black uranium oxide, to be filtered from the water leach liquors.

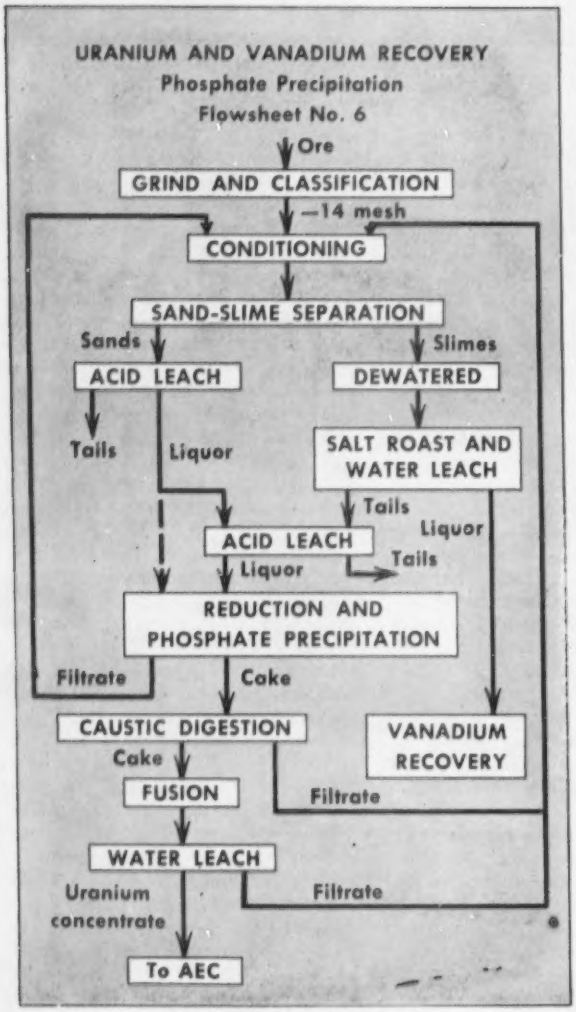
Thus, in carbonate leaching, conversely to recovering uranium from a purified liquor, an impure uranium concentrate is precipitated which is purified by a fusion.

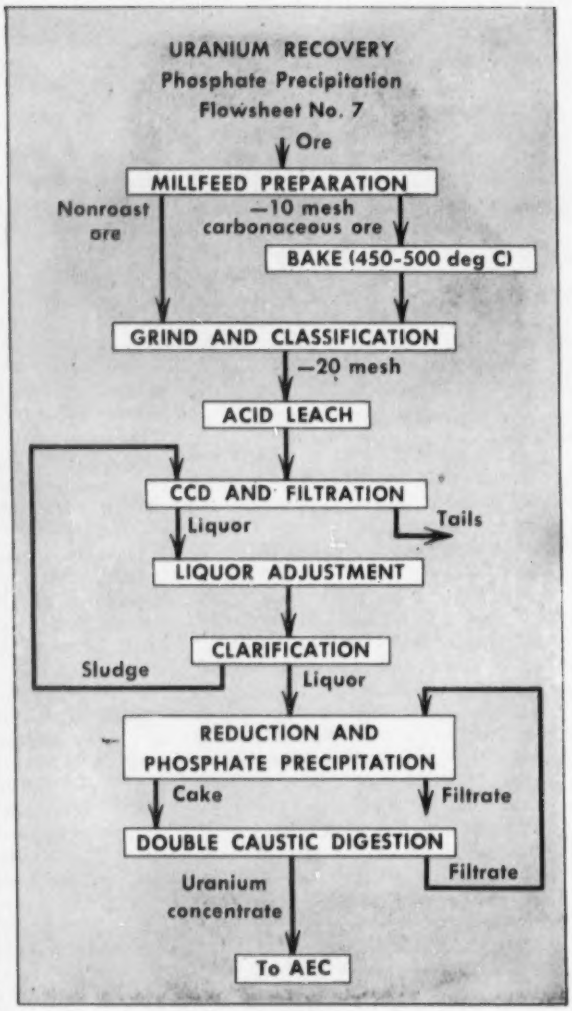
Although one mill, Monticello, did leach the calcine in sodium carbonate solution at 90 deg C for a period long enough to solubilize about 90% of the uranium and discard the resultant tailing, the Durango and Naturita mills do not do this; and in order to make a throw-away tailing, calcine from the carbonate leaching operation is dewatered and then given a leach with several per cent sulphuric acid, which recovers an additional 15 to 20% of the uranium and vanadium mill feed values left in the carbonate leach tailing. This acid liquor is then neutralized with an excess of sodium carbonate, and the alumina sludge formed is filtered from the sodium carbonate liquor and washed with disk filters. This liquor retains the uranium and vanadium values and is used for the carbonate mill solution.

So much for initial uranium recovery circuits. They involve traveling up and down the pH scale with acids and bases; however, they are metallurgically and chemically sound and well developed; and as yet, no other circuits have been found as suitable for recovering uranium in conjunction with vanadium recovery.

Later Developments for Uranium Recovery

Phosphate Precipitation. About 1950, a new process was thought to be feasible on a plant scale, wherein uranium was precipitated from acid leach liquors as a uranous phosphate.



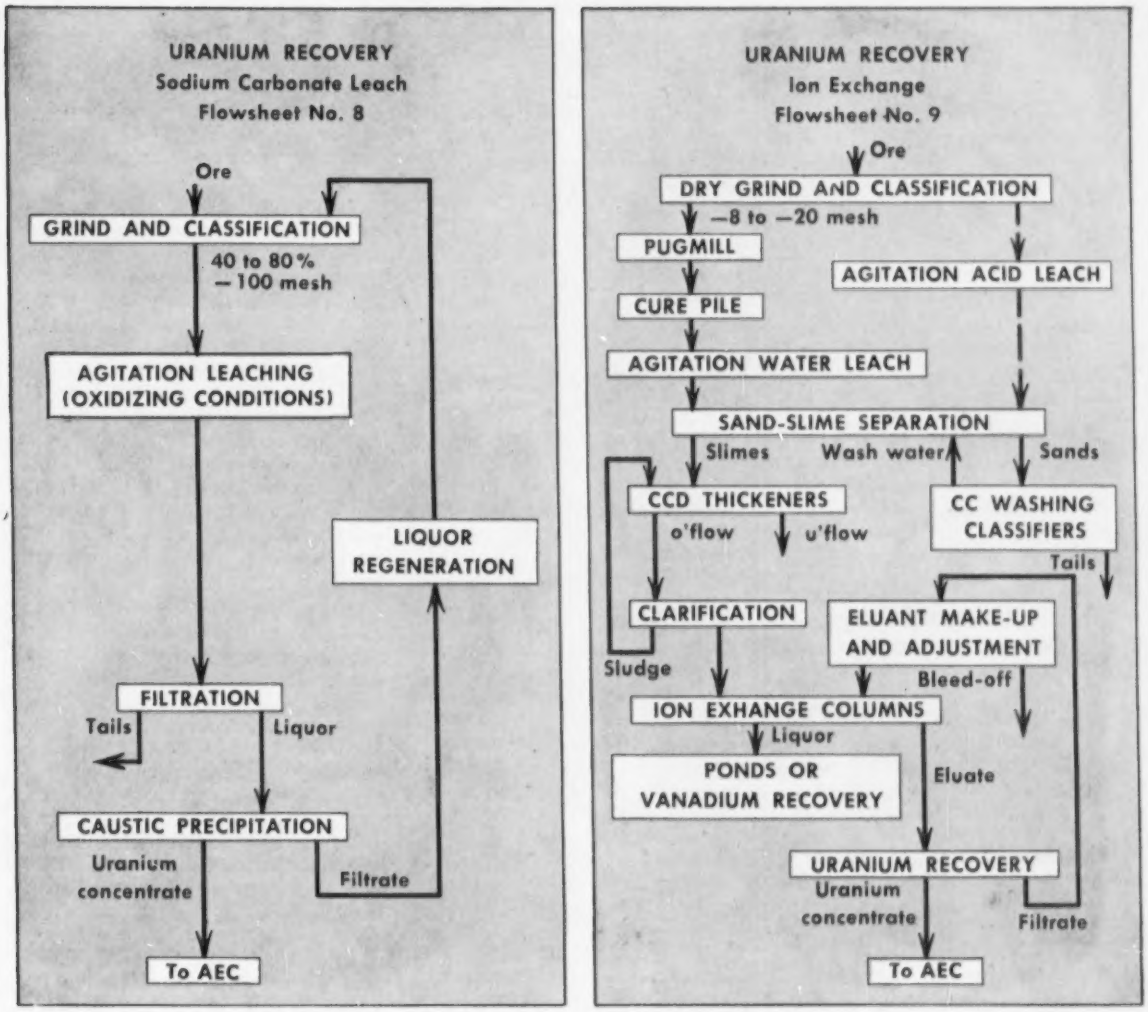


It was based on the fact that uranous phosphate will precipitate from acid liquors, and accomplishes a somewhat selective removal of uranium, giving a much higher grade uranium cake than could be obtained in a green sludge formed by neutralizing the acid liquor. This precipitation is made by reducing solutes in acid liquors with a reducing agent, such as iron or aluminum, and having enough phosphate in the liquor to combine with the uranous ion as it is formed, although several times the theoretical amount of phosphate is necessary.

Possibilities of such a process appeared to be quite attractive, two of the reasons being the saving incurred by not having to neutralize large quantities of acid liquors for uranium recovery, along with the better than 35% U_3O_8 concentrate initially obtained. Between 1950 and 1952, the next two uranium mills which went into operation on the Colorado Plateau, Climax Uranium Co. and Vitro Chemical Co. (now Vitro Uranium Co.), installed this process. The flowsheets are shown by No. 6 and 7. However, the uranium precipitate was high in phosphate and still too low in grade, so refining steps had to be performed to purify the precipitate further to make an acceptable product. Another feature was that the precipitation was not quantitative, with the degree of precipitation being extremely sensitive to many variables in the liquor composition.

First of the two mills to use the phosphate precipitation process, Climax Uranium Co., incorporated a salt roast and water leach for vanadium recovery in its flowsheet since mill feed was to be typical Colorado Plateau carnotite ores. Climax also installed a sand-slime separation step which concentrated approximately 70% of the values into the minus 150 mesh fraction that comprised 30 to 40% of the weight of the ground ore. This decreased, by about two-thirds, the tonnage of ore it was economic and necessary to salt roast for vanadium solubilization.

Climax' flowsheet was advantageous for solving the high barrens problem. The mill flowsheet, Flowsheet No. 6, incorporates an ore conditioning step in which the residual acid in the uranium barren liquor is used for neutralizing the lime in the raw mill feed pulp from the wet grinding circuit. This, in turn, neutralizes the barren liquor and precipitates all of the contained uranium and vanadium values into the pulp, along with soluble alumnia, silica and iron. These precipitated values follow the slime portion of the ore and the salt roast dehydrates, and makes alumina and silica insoluble, which prevents a build-up of these im-



purities at any point in the mill circuit.

Calcines are water-leached for vanadium recovery and are next acid-leached for uranium recovery and to scavenge for the acid soluble vanadium. The sands, which were initially separated from the slimes, are acid-leached for the same purpose. These acid liquors are then sent to the phosphate precipitation step for uranium removal.

Vitro Chemical Co., the other mill to use phosphate precipitation, was the first mill built for uranium recovery exclusively; and the ore is not subjected to a high temperature salt roast, but is given either a preliminary 450 to 500 deg C bake to remove the interfering carbonaceous material and destroy the uranium-carbonaceous complex before acid-leaching, or the noncarbonaceous ore is acid-leached without preliminary treatment, other than grinding to minus 35 mesh. Baking operation also improves settling and filtering rates of the ore.

This mill had no way of preventing alumina and silica build-up in the circuit if either the high barren liquor or a precipitated sludge containing the values were recycled. Difficulties encountered in the phosphate precipitation process were further aggravated by major changes in the type of ore fed; but after a comprehensive two-year program of research and investigation, a system of solution control was finally developed which makes it possible to precipitate 97.5% of the uranium values from the solution.

Carbonate Leaching. Meanwhile, a great deal of successful work had been done by the Canadians on pressurized carbonate leaching the raw ores. Discovery and development of large uraniferous limestone orebodies in the western U. S., averaging from 60 to 90% lime, along with the continuing discovery of smaller orebodies containing between 20 and 35% lime, made it necessary for the AEC and prospective uranium concentrate producers to investigate and consider the technique of carbonate leaching raw ores, as the acid consumption and ensuing salts relegates against any form of acid attack.

Next uranium mill to come into operation, Anaconda's Bluewater, N. M., mill, was built to handle nearby uraniferous limestone ores. Its hot carbonate leach operates under 15 to 30 psig pressure. Liquor is removed by filtration. Uranium is precipitated from the liquor as a sodium salt by addition of caustic. Although precipitation is not quantitative, this is of little concern, since the stripped caustic-containing liquor is carbonated with flue gases in a grid tower and returned for use as mill leach solution.

Ion Exchange

ION EXCHANGE for metal recovery is a relatively new metallurgical operation, and along with the definition of certain terms, will be briefly reviewed with respect to its application to uranium recovery. The following terms are applicable to ion exchange practices in general:

ADSORPTION, LOADING, OR EXHAUSTION . . . Uranium (or ions) removed from solution by resin adsorption.

ELUTION . . . Removing the uranium (or desired ions) from the resin with an eluting solution.

ELUANT . . . The chemically adjusted eluting solution used for elution (barren of desired ions).

ELUATE . . . The uranium rich or pregnant eluting solution after elution (contains desired values or ions removed from resin by elution).

Strong base anion exchange resins selectively adsorb the uranium as uranyl di- and tri-sulphates from sulphuric acid leach liquors. The ion exchange feed is generally adjusted so that its pH is between 1.3 and 1.7, and the emf. is between −0.350 to −0.450mv (vs S.C.E.) for optimum uranium ion exchange conditions and to suppress the ion exchange competition of other metallic anions.

Operational uranium loadings range from 1.5 to 4.5 lb of U_3O_8 per cubic foot of wet settled resin (WSR), depending upon the particular conditions of the liquor and the resin. When the resin has adsorbed its capacity of uranium, the resin is washed; and then the uranium is removed by an eluant which restores the resin for reuse. The eluants most commonly used contain approximate molar concentrates of ammonium or sodium salts of nitrates or chlorides, with the pH adjusted to between 1.0 and 1.5 with the corresponding anionic acid.

In practice, sulphuric acid is frequently used for the pH adjustment. The chloride or nitrate creates an unfavorable environment for the resin to retain the uranyl sulphates, and they are replaced by chloride or nitrate anions, which in turn are replaced by the uranyl sulphates in the loading cycle.

A ratio of uranium concentration from 5:1 to 20:1 is achieved from the leach liquor to the eluate. The uranium is precipitated from the eluate by neutralizing with a base, such as caustic, ammonia or magnesia, and filtered from the solution. The resulting filtrate is then chemically adjusted and reused for eluant, although a certain bleed-off and resulting make-up may be necessary to prevent undesirable build-up of certain ions.

Choices of eluting and precipitation chemicals, eluting schemes, and ion exchange cycles, and techniques vary and are mainly influenced by the economic factors confronting each particular plant.

This is seen in Flowsheet No. 8.

Ion Exchange. Prior to 1950, research contractors of the AEC had developed in the laboratory the use of ion exchange for recovering uranium from acid leach liquors. This technique was piloted on a small scale in several places and adopted for use in the extensive South African uranium recovery operations where ion exchange columns are used to recover the uranium from sulphuric acid leach liquors.

Ion exchange eliminates one of the objectionable features of acid leaching which dissolves a multitude of constituents from the ore besides uranium; and as explained, requires extensive processing to recover a good grade uranium concentrate from acid leach liquors. Ion exchange resins will preferentially adsorb uranium from the other solutes in the liquor, and this makes acid leaching much more attractive from a cost and metallurgical standpoint. This and the fact that mill feed for uranium mill No. 9, built by Kerr-McGee Oil Industries, Inc., at Shiprock, N. M., would contain around 1% vanadium, which it was felt necessary to recover at that time, resulted in the mill being built to use an ion exchange-acid cure process.

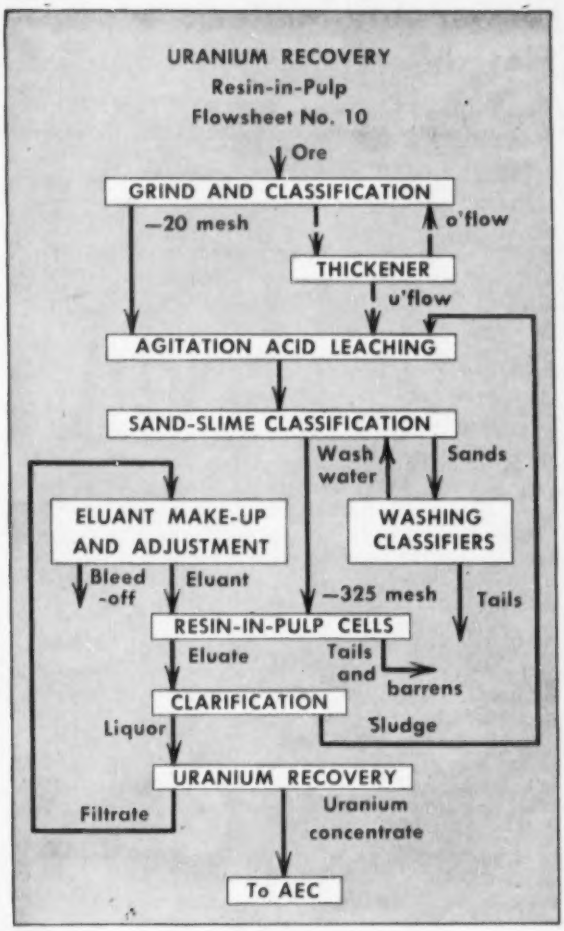
Merits of the acid cure were based on vanadium recovery which could not be achieved by salt roast because of high lime content (7 to 9%) of the mill feed. Although such a process had been recognized and used in the past, a program of process development by AEC research contractors resolved many questions on certain techniques in the acid cure.

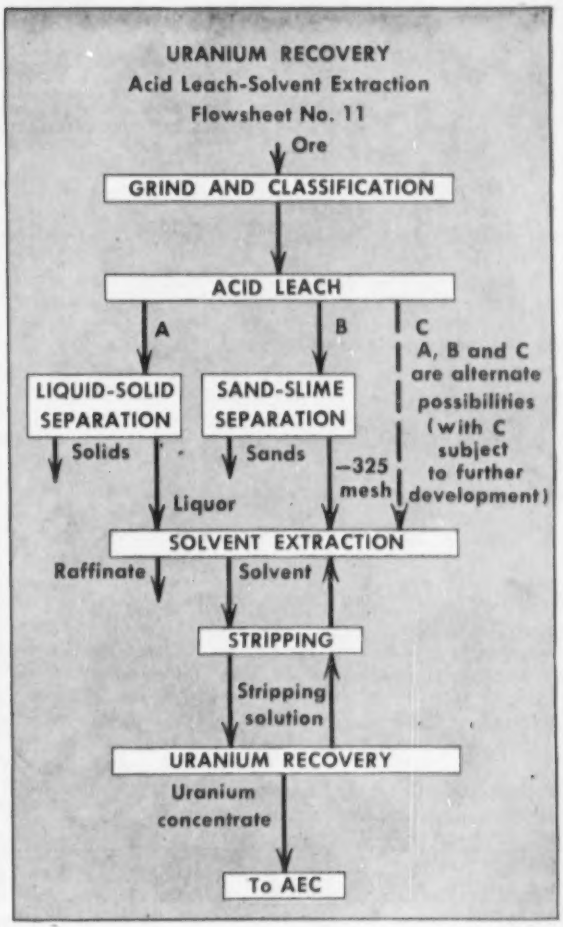
Ore is pugged with water (roughly 10%) to furnish enough moisture for hydration of the gypsum formed during the cure and to keep the cure moist, and with approximately 250 to 300 lb of acid per ton of ore in excess of that necessary to neutralize the ore. The mixture is allowed to cure in a pile; and with an exothermic rise in temperature, solubilization of uranium and vanadium values takes place within several hours. The cure is then water-leached, taking into solution the excess acid and solubilized uranium and vanadium. Uranium is removed from solution by ion exchange columns.

Originally, effluent liquor from these columns was sent to tanks where the pH was adjusted to about 2.5 to remove vanadium as a mixture of vanadyl hydrates and iron vanadates for further processing to an 86% V_2O_5 fused pentoxide. However, a declining vanadium market at the time this mill started operation and the sacrifice of uranium production to work out operational bottlenecks in vanadium recovery made it desirable to forego vanadium recovery. Vanadium-containing slimes and liquors are now impounded for vanadium recovery at some later date. Thus, the flowsheet for this plant, Flowsheet No. 9, is now for uranium recovery alone.

Enough acid is added in the acid cure for uranium recovery, and pulp from the water leach goes to sand-slime separation where sands are countercurrently washed in classifiers, and slimes countercurrently washed in thickeners. Resulting liquor goes through ion exchange columns. Uranium is adsorbed on the resin, and the ion exchange effluent is sent to impounding areas. Uranium is removed from the resin by an eluting solution which restores resin for reuse. Uranium precipitated by neutralizing the eluting solution is removed from the solution by filtration, and dried.

As mentioned, the acid cure was originally installed for vanadium recovery as well as uranium recovery. It involves more difficulty in processing and handling ore than simply acid-leaching the raw ore, although the cure does give better settling slimes for countercurrent decantation. Shiprock mill is now installing an acid





leach in its circuit for uranium dissolution.

Recognizing the advantage of ion exchange in selectively removing uranium from acid solutions, U. S. Vanadium did pilot work on this process; and finally, in the first part of 1955, started operation of a full scale column ion exchange unit in connection with the completed Uravan mill expansion. This flowsheet is Circuit B on Flowsheet No. 5, and the Uravan mill now uses a combination of the two flowsheets.

Ore containing over 3% lime is sent to an initial acid leach and conditioning operation which destroys the lime, along with leaching 75 to 80% of uranium from the ore. Dewatered tails then go to the salt roast. All uranium-pregnant mill liquors flow through the ion exchange columns for uranium recovery. Ion exchange effluent is sent to neutralization to precipitate the vanadium and any uranium which might have escaped the ion exchange. Sludges are returned to the circuit for value recovery.

Resin-in-Pulp. Clear liquors necessary for ion exchange columns are obtained by filtration or thickening with further liquor clarification, if necessary. Due to poor washing, soluble losses of several per cent are not uncommon in filtering and thickening circuits. If good operation keeps soluble loss below 1%, cost of further reduction of soluble losses probably would not be economically warranted.

Capital investment for an acid-proof filter plant is high; and capital cost of an acid-proof thickening installation is also high, although operating and maintenance costs for thickening are lower than for a filter plant. However, a filtration plant uses less dilution water; and therefore produces higher grade liquors. The bentonitic slimes of the western U. S. sedimentary uranium ores cause slow filtering rates and necessitate large thickening areas. Development of the polysaccharide and other new thickening and filtering reagents during the past two years has been of great assistance in alleviating this trouble.

By 1952, it was evident that the production of a clear liquor for ion exchange columns necessitated a large investment and troublesome operations. This had been foreseen; and in 1950, exploratory work had been started by a Division of Raw Materials research contractor to develop a process in which the uranium was adsorbed on the resin directly from the pulp. It was found that this could be done readily, and the main problem involved resin and pulp separation techniques which eventually led to the production of a plus 20 mesh resin and screening device for separating the resin from the pulp.

In 1952, construction was started on the first of several pilot plant resin-in-pulp circuits on the compound of the Grand Junction Operations Office.

II Ore Characteristics For Suitable Millfeed In Available Flowsheets

Suitability of ore is determined by lowest rating received in any characteristic.
Ranges of demarcation are not distinct, but each suitability rating decreases with an increasing characteristic content.

Ore characteristics	Flowsheet No. 4	5A	5B	6	7	8	9	10
I. Uranium mineralization								
(1) % Oxidized (U^{+6}) — % Reduced (U^{+4})								
(a) 100 to 75 — 0 to 25	A	A	A	A	A	AO	A	A
(b) 75 to 50 — 25 to 50	B	B	B	AO	AO	AO	AO	AO
(c) 50 to 25 — 50 to 75	C	C	B	AO	AO	AO	AO	AO
(d) 25 to 0 — 75 to 100	This condition seldom exists and 100% U^{+4} minerals are not found in nature.							
(2) Primary combined oxides and fluorides	D	D	D	D	D	D	D	D
II. Carbonaceous or asphaltic content								
(1) <0.5%	A	A	A	A	A	A	A	A
(2) 0.5% to 2%	A	A	A	A	A	B	B	B
(3) 2 % to 15%	C	C	C	C	B	D	D	D
(4) >15%	D	D	D	D	D	D	D	D
III. Vanadium (V_2O_5) content								
(1) <0.75% V_2O_5	Not desired by mills recovering vanadium.				A	A	A	A
(2) 0.75% V_2O_5 and greater	A	A	A	A	B	C	B	B
IV. Lime ($CaCO_3$) equivalent content								
(1) <3%	A	A	A	A	A	A	A	A
(2) 3% to 6%	B	B	A	A	A	A	A	A
(3) 6% to 18%	D	D	B	B	B	A	B	B
(4) >18%	D	D	D	D	D	A	D	D
V. Gypsum ($CaSO_4$) equivalent content								
(1) <1%	A	A	A	A	A	A	A	A
(2) 1% to 3%	A	A	A	A	A	B	A	A
(3) >3%	A	A	A	A	A	D	A	A
VI. Primary slimes (minus 350 mesh) content								
(1) <10%	A	A	A	A	A	A	A	A
(2) 10% to 40%	A	A	A	A	A	A	A	A
(3) 40% to 80%	C	C	C	C	C	D	C	B
(4) >80%	D	D	D	D	D	D	D	C

Notes:
A — Suitable for flowsheet mill feed.
B — Can be blended into suitable mill feed.
C — Small amount can be blended into suitable mill feed.
D — Not economic to process or unsuitable for mill feed.
O — Oxidizer probably necessary.
> — Greater than.
< — Less than.

This circuit utilized the principle of suspending a screen basket of the resin in the fluid stream and slowly moving the basket up and down to keep the resin in motion and in effective contact with the passing, dilute pulp. It was necessary to remove the plus 325 mesh portion of the ground and leached ore to prevent sanding in the tanks or cells in which the baskets were suspended. This pilot plant began operation in March 1953; and during the past three years, it and its successors have successfully operated at 5 to 12 tpd rates on a large variety of uranium ores.

The resin-in-pulp (RIP) flowsheet is No. 10, and consists of grinding and leaching circuits and a classification and sand-washing circuit where the sand-slime separation is made with the liquor containing 6 to 8% solids going to the RIP cells. There, the liquor flows through a number of cells in series, each cell containing an oscillating basket of resin which adsorbs the uranium. Cells are arranged in multiple units called "banks" which constitute a unit of change. Barren effluent may or may not be neutralized for disposal. As the resin in the first bank of a series becomes loaded with uranium, the bank is taken out of the loading cycle and the next bank following the loading series is put into the circuit; and so the loading cycle is advanced through the series of cells and banks. Uranium is removed from the resin by an acidic eluting solution, with the eluting cycle following the loading cycle on each bank in series. Uranium is precipitated from the eluate by adding a base, and removed by filtration. The filtrate is chemically adjusted for eluting reuse.

Extensive tests at the Grand Junction pilot plant successfully demonstrated the applicability and specific advantages of the RIP process; and the next three uranium mills to be built, all still in construction, will use the RIP circuit. In addition, two of the uranium ore processing facilities have installed and are operating the RIP process in recently-completed mill expansions. These facilities are Anaconda's Bluewater, N. M., mill which installed an acid leach circuit to process ore from its Jackpile mine, and the Commission-owned mill at Monticello, Utah, which added an acid leach circuit to process tributary ores that responded better to an acid leach.

During construction of the acid leach-RIP circuit at the Monticello mill in the summer of 1955, the salt roast-carbonate leach circuit was converted to a raw ore-carbonate leach-caustic precipitation circuit because the average vanadium content of the mill feed had dropped below the limit for economic recovery. Lime content of the tributary ores and ore reserves had increased to between 10 and 20% which precluded salt roasting anyway, and better uranium extractions generally could be accomplished by carbonate leaching these raw ores. Monticello mill's carbonate leach is performed at atmospheric pressure. This requires a longer contact time than pressurized carbonate leaching.

Suitable Mill Feed

A matter of paramount importance that has always confronted the uranium mill operators is the response of an ore to a specific milling process or flowsheet, often loosely referred to as

"amenability." One might define amenability as being directly proportional to recovery and inversely proportional to total cost, or

$$\text{Amenability Rating} \propto \frac{\text{Lb value recovered per unit}}{(\text{Ore cost} + \text{processing cost}) \text{ per unit}}$$

Naturally, the ore most suitable for a mill feed is the ore with the highest amenability rating for the particular milling process used. Many times, ores that are acceptable metallurgically to a mill are undesirable as long as that mill has a supply of ore more economically desirable.

Therefore, it is difficult to designate a uranium ore as being amenable or not amenable to a certain mill or its flowsheet, since each mill attempts to operate under the most favorable economic schedule possible. Ores that may not be accepted for processing at one mill may be acceptable to another mill having either a different process and/or economic condition. Again, six months later, the ore may be acceptable to the same mill which formerly refused it, depending upon the comparative available ore supply.

Generally speaking, there seem to be seven characteristics of uraniferous ore found in western U. S. that substantially influence their amenability with respect to the different mills and flowsheets.

I. Uranium Mineralization:

(1) Oxidized (U^{+6}) to reduced (U^{+4})—With proper leaching conditions, it is readily possible to leach uranium from ores having distinct uranium mineralization. Although, as the predominant uranium mineralization changes from oxidized to reduced, leaching becomes more difficult with increasing amounts of oxidizer necessary. Secondary uranium minerals can always be leached, giving good extractions, while some primary uranium minerals may be too finely disseminated for good extractions. A proper salt roast will oxidize a uranium ore, although it can also change the uranium into insoluble salts if care is not taken.

(2) Primary combined oxides and fluorides—Uranium in chemical combination with oxide of iron, columbium tantalum and/or titanium and varying amounts of rare earths and thorium cannot be extracted with normal leaching conditions. The same is true for the uraniferous fluorspars.

II. Carbonaceous or Asphaltic Content:

Excessive carbonaceous material must be destroyed to permit good uranium extractions and prevent fouling of solutions.

III. Vanadium Content:

This is an economic consideration for mills recovering vanadium, and mills not recovering vanadium are not inclined to pay for the vanadium in the ore.

IV. Lime ($CaCO_3$) Equivalent Content:

Lime content is a measure of acid consumption by the ore and accompanying conomics and handling problems. One pound of lime consumes one pound of sulphuric acid. However, lime may not be the only acid-consuming constituent of an ore, so "lime equivalent" is used.

V. Gypsum ($CaSO_4$) Equivalent Content:

Gypsum or calcium sulphate content is a measure of the sodium carbonate consumption of ore and accompanying economics. Roughly, one pound of calcium sulphate will consume 0.8 pound of sodium carbonate. However, gypsum may not be the only sodium carbonate consuming constituent of an ore, so "gypsum equivalent" is used. Pyrite, if present, will also consume some sodium carbonate.

VI. Primary Slimes (minus 350 mesh) Content:

This is mainly a consideration of liquid-solid separation characteristics.

VII. Ore Grade:

Uranium content is a major economic consideration.

Although there may be certain other ore characteristics that exert a minor influence in mill choice, the above-listed seven characteristics are the basic and main influences.

To avoid some of the fluid and debatable ramifications of amenability, the more specific term "suitable mill feed" has been utilized, and Table II has been prepared, which rates the characteristics of uranium ores with respect to what is the most suitable for mill feed to a particular flowsheet or process. In other words, the table shows the ore characteristics which each flowsheet can and cannot readily handle. Ore grade, characteristic No. VII, has been omitted since, obviously, other things being equal, the higher grade the mill feed, the better for any mill.

In using Table II, an ore is only as suitable for a flowsheet as is shown by the lowest rating it receives for any ore characteristic. However, there are actually no well defined ranges of demarcation as are necessarily used in Table II since the process of blending does give a certain amount of latitude.

Future Processes For Uranium Recovery

Due to the critical need for uranium concentrate, along with the desire to obtain this concentrate at the lowest possible cost, AEC's raw materials program continues to incorporate research and process development to obtain better uranium recoveries, to lower uranium ore processing costs, and to find feasible means and develop flowsheets for processing ore types which either are not amenable or economic to circuits already in use or developed.

Since one of the criticisms of the presently used ion exchange techniques is that they are not continuous, a considerable amount of effort is now being directed to develop methods for continuous ion exchange by moving the resin countercurrent to the advancing clear liquors or slime pulps. Continuous ion exchange will separate the loading (exhausting or contacting) zones from the eluting (regeneration) zone, and so lends itself to better design for the specific functions of each zone. Continuous ion exchange will use less resin, less wash water, and make more efficient use of the eluting chemicals; equipment will be smaller, more compact and subject to easier control than by present methods.

AEC's research contractors, independent organizations, and individuals have had ideas on continuous and semi-continuous ion exchange techniques. Types of equipment embodying several approaches to the problem are in the pilot plant stage of development, and it is anticipated that one or several methods may soon be ready.

As previously mentioned, carbonate leaching is particularly attractive on the higher lime ores (10 to 20% $CaCO_3$) and is a "must" on high lime ores; but many ores in the range of 10 to 35% lime have been particularly difficult to filter. Recently, new filtering techniques developed by Commission research groups have raised filtering rates on such ores from 100 to 200 lb per square foot per day to about 600 to 800 lb per square foot per day, with the use of flocculating reagents.

In the meantime, an attempt has been made to apply ion exchange and resin-in-pulp techniques to carbonate leach liquors. Under proper conditions, and by using specific eluting reagents,

Acknowledgment

While the history of an industry can be reported by relating the chronological developments, occasions and installations of new processes, modifications and new plants, this is not the real history nor the most interesting one. The real history of the Colorado Plateau uranium milling operations, and one likely never to be reported, goes with the men; the managers, the superintendents and their staffs, who have pioneered and started up the large-scale uranium milling operations. The real history flourishes with long hours, hard work, sweat, pathos, humor, disappointments and accomplishments, all crowded into a short span of time.

It has been my privilege to be associated with this group of men for the past six years; and their sincerity, tenacity and productivity have always been amazing. To them all, I gratefully acknowledge the interest and cooperation which they have continually given, and extend my appreciation for their respective permissions to publish the flowsheets and discussions of the pertinent milling processes.

Wm. L. Lennemann

the same resin can be used for ion exchange recovery of uranium from carbonate solutions as is used for recovery from acid solutions; and at this time, resin-in-pulp techniques on carbonate leach liquors appear to be quite successful. A carbonate leach-RIP circuit would eliminate the costly acid-proof equipment of an acid leach circuit as well as the liquid-solid separation which formerly was necessary for a carbonate leach circuit. An additional stimulus to carbonate leaching circuits is the fact that carbonate leaching techniques have now been developed to the point where uranium extractions made with carbonate leach liquors are comparable to extractions achieved with acid leaching on many ores. Here it should be emphasized that the carbonate leaching conditions must be carefully controlled; and generally speaking, acid leaching still enjoys an extractive advantage.

When exploring future flowsheets, considerations should be given to liquid-liquid solvent extraction. Liquid-liquid solvent extraction techniques are used to recover uranium concentrate as a by-product in the phosphate rock processing plants where the small amount of uranium contained in the phosphoric acid liquors is selectively extracted with octylpyrophosphoric acid in kerosene.

In the feed material refineries, initial steps are digesting the uranium concentrates in nitric acid and selective solvent extraction of the uranium from the nitric acid digestion liquors with either tributyl phosphate in kerosene or straight diethyl ether. Liquid-liquid solvent extraction techniques have not yet been applied on a large scale to recover uranium directly from the ore.

The most satisfactory reagents developed for selective uranium solvent extraction from the sulphuric acid leach liquors appear to be certain of the long branch chain alkyl amines and alkyl phosphates carried in cheap organic diluents, such as kerosene. In the liquid-liquid extraction of pulps and dirty solutions, there seems to be considerable loss of the amines in the raffinate due to adsorption on the solids. Phosphates do not have this characteristic, but the liquor emf. must be adjusted for uranium extraction by the alkyl phosphates since these compounds also extract vanadate and ferric ions along with uranium. Alkyl amines have low extraction coefficients for vanadate and ferric ions at low pH's, and no liquor reduction is necessary for selective uranium extraction.

During the past five years, research contractors for the Commission have been vigorously exploring and scanning the application of liquid-liquid solvent extraction to uranium recovery from raw materials. This has progressed to a point where, for the past two years, the Intermountain Experiment Station, U. S. Bureau of Mines, Salt Lake City, Utah, has operated a nominal 150 lb of ore per hour solvent extraction pilot plant. Vitro Uranium recently constructed and started operating a solvent extraction pilot plant, and Kerr-McGee is conducting large scale experiments with solvent extraction at its Shiprock mill. Climax Uranium is operating bench scale solvent extraction units in order to obtain data for evaluating a commercial plant installation.

The consensus is that solvent extraction has now been proved applicable for clear liquors and dilute slime pulps (less than 4.0% solids). The effort is to make solvent extraction directly applicable to the thick leach slurries (20 to 50% solids) where the problem is coping with or eliminating the entrainment of the organic in the raffinate.

In the continuing attack against processing costs, lowering of reagent costs for uranium leaching and uranium recovery or precipitation has been given much thought, and combined with this was the belief that it should be possible to use ammonium carbonate as well as sodium carbonate for carbonate leaching uranium ores and to utilize an ammonia recovery cycle. It has now been found that ammonium carbonate leaching is quite effective for some ores under pressures of 90 to 110 psig and at temperatures of 100 to 120 deg C. Ammonia can then be stripped from the ammonium carbonate solution, recovered in a scrubber and the ammoniacal liquor carbonated to produce the ammonium carbonate leaching reagent.

Uranium is precipitated as uranyl oxide dihydrate when ammonia and carbon dioxide are stripped from the pregnant leaching solution. Such a process is extremely attractive from the standpoint of reagent costs, and should outweigh the cost of the additional equipment necessary. However, several of the fundamental operations are yet to be thoroughly checked, and considerable trouble has been encountered by the formation of an insoluble ammonium uranyl vanadate in leaching vanadiferous uranium ores. Testing this ammonium carbonate leaching process in 10- to 15-tpd pilot plant equipment is now under consideration.

This article has incorporated an attempt to show the rapid development of uranium metallurgy during the past six years and to give some clue to the recent developments which have not yet been installed on a plant scale. Continuing work by AEC research contractors is being done on developing other processes, some of them quite novel, which have good prospects for being better methods for recovering uranium from its ores. Discussion of these has been omitted because, as yet, they have not been completely explored by bench scale work.

It is obvious that, at this time, there is no recognized standard design for a uranium mill, nor is there likely to be one for some time to come.

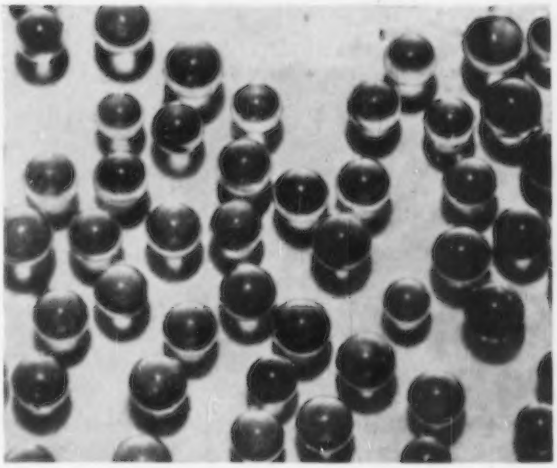
Try Ion Exchange For Complex Ores

HYDROMETALLURGY leans more and more toward the use of ion exchange as a way to handle complex and/or lean ores. We now have 39 different ion exchange resins on the market; each one tuned to do a specific job. Here and on the following two pages we list all the resins available, their manufacturers and their chemical-physical characteristics.

Ion exchange interchanges ions in a pregnant solution for ions from a solid organic compound. The solid doesn't change very much, it just gives up its ions for anions or cations in the solution. Cationic resins are sulfonic, carboxylic or phosphonic chemicals. Anions are amines or quaternary ammonium compounds that are weakly acid, strongly basic or in between.

After the resin has been loaded with captured ions in a batch, semi-continuous or counter-current process, it must be regenerated. This is done with a chemical for which the resin has a greater affinity than the resin has for the captured ion. On uranium-laden resins, acidic solutions containing sodium or ammonium salts of chlorides and/or nitrates regenerate the resins.

Ion exchange resins are poisoned by certain compounds. These poisons interfere with extraction and regeneration



RESINS in pellet form are tough, and stand up well against abrasion. They will last about ten years in uranium leaching.

Here Are The Ion Exchange Resins You Can Buy

Cation Exchangers

Trade mark	Manufacturer‡	Active groups	Capacity range*	Temperature limitations	Actual uses	Potential uses	Remarks
Chempro C-20	A	Nuclear Sulfonic	10–48	220 deg F	Water conditioning Metal recovery Separations Concentration	Recovery of metallic cation values Ion exclusion	High capacity Medium porosity Polystyrene Bead form Conventional
Duolite C-25	A	Nuclear Sulfonic	10–36	220 deg F	Water conditioning Metal concentration	Complex adsorption Radioactive waste treatment	Intermediate capacity
Nalcite HCR	B	Polystyrene Sulfonic	20–30	250 deg F	Water softening, deionization; metal concentration and recovery		A high-capacity styrene-base exchanger
Nalcite HGR	B	Polystyrene Sulfonic	20–33	250 deg F	Hot process softeners, mixed bed deionizers, metal recovery		A heavier duty industria grade of Nalcite HCR
Nalcite HDR	B	Polystyrene Sulfonic	20–35	250 deg F	Chromic acid purification		An even more resistant resin. Normally for specialized uses only
Permutit Q	C	Sulfonic	Up to 35	250 deg F	Copper recovery Rare earth separation Water softening	Cationic metal recovery	Sulfonated styrene Copolymer Requires relatively high acid concentration High capacity and excellent stability
Amberlite IR-120	D	Sulfonic	Up to 41.5 kgr	250 deg F	Separation and recovery of rare earths Recovery of metals from acid wastes Purification of chromic and phosphoric acid solutions Removal of radioactive materials from solution Separation of multivalent cations from monovalent cations Water conditioning	Recovery of meta values from mine drainage waters Separation of zirconium from hafnium Analysis of natural streams to determine location of mineral deposits Chromatographic resolution of metals Purification of organic liquids	Chromatographic grades also available Supplied in Na form

‡A Chemical Processing Co. B National Aluminate Corp. C Permutit Co. D Rohm & Haas Co. *Preferably expressed in kilograms per cubic foot.

Here Are The Ion Exchange

Cation Exchangers *(Continued)*

Trade mark	Manufacturer‡	Active groups	Capacity range*	Temperature limitations	Actual uses	Potential uses	Remarks
Duolite C-3	A	Methylene Sulfonic	8–28	140 deg F	Water conditioning Nickel removal from water	Metal separations Acid catalysis	Offers economy in regeneration Phenolic Granular, porous
Duolite C-10	A	Methylene Sulfonic	5–12	120 deg F	Amino acids	Metal separations Radioactive waste treatment	Low capacity Economy in regeneration Phenolic Granular Highly porous
Zeo-Karb	C	Sulfonic Carboxylic	Up to 9	140 deg F	Copper recovery Hydrogen exchange Water softening	Cationic metal recovery	Sulfonated coal Low acid concentrations are effective regenerants
Duolite CS-101	A	Carboxylic	5–100	180 deg F	Copper recovery	Metal separations Isolation of large cations	High regeneration efficiency, maximum capacity attainable at high pH Weak base Acrylic Bead form
Permutit H-70	C	Carboxylic Acid	Up to 70	140 deg F	Copper recovery	Separation of metal cations	Carboxylic acid Slow reaction rate High acid efficiency
Amberlite IRC-50	D	Carboxylic	Up to 71.0 kgr	250 deg F	Recovery of metals from weakly acid to alkaline solution Separation and recovery of cobalt-nickel-copper Removal of free bases from aqueous and non-aqueous solutions	Concentration of dilute metal values Separation of cadmium and zinc Purification of organic liquids	Chromatographic grades also available Supplied in H form

Anion Exchanges

Duolite A-114	A	Secondary and tertiary amine	20–40	200 deg F	Water conditioning Deacidification Amino acids	Strong acid removal Decolorizing	High porosity, good stability, economy in regeneration, hydrocarbon matrix, weak base, beads, porous
Duolite A-14	A	Secondary and tertiary amine	20–40	200 deg F	Water conditioning	Strong acid removal	Conventional type Good stability Economy in regeneration Polystyrene matrix Weak base, beads
Duolite A-2	A	Secondary and tertiary amine	10–35	140 deg F	Water conditioning Copper removal	Sulphite waste treatment Metal recovery	High porosity. General purpose exchanger Phenolic—granular
Duolite A-7	A	Secondary and tertiary amine	12–35	120 deg F	Water conditioning	Strong acid removal Waste treatment	Low cost. General utility weak base exchanger Highly porous. Phenolic—granular
Duolite A-4 A-6	A	Tertiary amine	12–30	160 deg F		Metallic waste recovery Acid removal from fermented liquors	High porosity, Stability to aldehydes and ketones. Phenolic, granular
Nalcite WBR	B	Polyamine weakly basic	15–25	200 deg F	Demineralization of water		Useful for removal of strong acids e.g. HCL, H_2SO_4, HNO_3
De-Acidite	C	Secondary and tertiary amine	Up to 20	120 deg F	Acid removal		Aliphatic. Polyamine Weak base, polyamine Adsorbs strong acids
Amberlite IR-45	D	Polyamine	Up to 43.0 kgr	212 deg F	Deacidification of aqueous and non-aqueous solutions. Water conditioning	Separation and recovery of metals. Deacidification—precipitation of metals. Glycerine purification	Chromatographic grades also available. Supplied in OH form
Duolite A-41	A	Quaternary and tertiary amine	10–35	100 deg F	Water conditioning		Offers economy in regeneration; bead or granular form available. Aliphatic matrix difunctional
Duolite A-30	A	Quaternary and tertiary amine	10–45	120 deg F	Water conditioning	Copper recovery Waste treatment	Economy in regeneration; bead or granular form available. Aliphatic matrix. Intermediate base

‡A Chemical Processing Co. B National Aluminate Corp. C Permutit Co. D Rohm & Haas Co. *Preferably expressed in kilograms per cubic foot

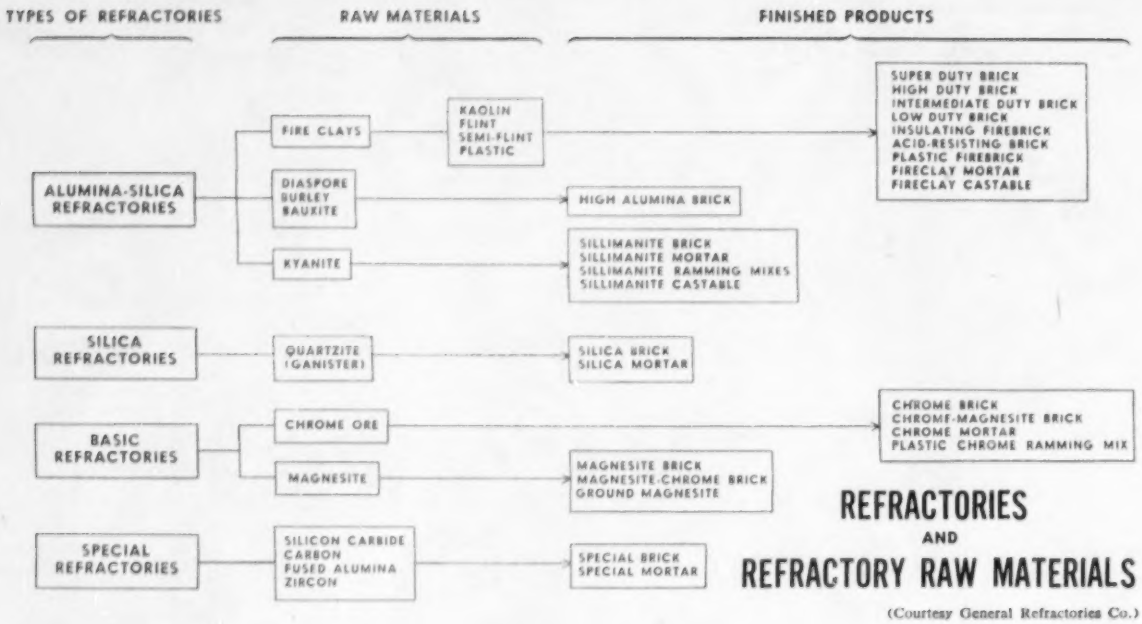
Resins You Can Buy

Trade mark	Manufacturer‡	Active groups	Capacity range*	Temperature limitations	Actual uses	Potential uses	Remarks
Permutit A	C	Quaternary and tertiary amine	Up to 25	120 deg F	Acid removal		Aliphatic intermediate base. Absorbs strong and weak acids
Duolite A-101	A	Quaternary Ammonium	6–18	140 deg F	Water conditioning Anion separations	Uranium recovery Waste treatment	Type I quaternary Good thermal stability Hydrocarbon matrix Strong base, porous
Duolite A-102	A	Quaternary Ammonium	8–20	100 deg F	Water conditioning	Leach liquors Rare earth separations Chromate recovery	Type II quaternary Less regenerant required than for Type I Hydrocarbon matrix Strong base, porous
Duolite A-40	A	Quaternary Ammonium	10–26	100 deg F	Water conditioning CO_2 and SiO_2 removal	Waste treatment Chromate recovery	Type II quaternary Polystyrene matrix Strong base, conventional
Duolite A-42	A	Quaternary Ammonium	8–22	140 deg F	Water conditioning Uranium recovery	Weak acid removal Catalysis	Type I quaternary Polystyrene matrix Strong base, conventional
Nalcite SAR	B	Type II, strongly basic quaternary	10–20	100 deg F	Water deionization with silica removal. Chloride cycle dealkylization		Sometimes more economical to regenerate than Nalcite SBR
Nalcite SBR	B	Type I strongly basic quaternary	10–20	150 deg F	Water deionization with silica removal. Chromate rinse water deionization		More stable, better silica removal than Nalcite SAR
Permutit S-1	C	Quaternary Amine	Up to 20	120 deg F	Chromate recovery Metal recovery	Separation of anionic metal complexes	Alkyl, amine, strong base. Adsorbs strong and weak acids
Permutit S-2	C	Quaternary Amine	Up to 20	120 deg F	Chromate recovery Metal recovery	Separation of anionic metal complexes	Alkanol, amine, strong base. Adsorbs strong acids
Permutit SK	C	Quaternary Amine	Up to 20	120 deg F	Uranium recovery	Separation of anionic metal complexes	Strong base. Adsorbs strong and weak acids
Amberlite IRA-400	D	Quaternary Ammonium	22.0 kgr	140 deg F (OH form)	Uranium recovery Recovery of chromium from solution. Separation and recovery of precious metals. Removal of radioactive materials from wastes. Purification of concentrated HCl. Water conditioning, including silica removal	Separation of wide variety of anionic metal complexes Chloride - bromide - iodide separation. Separation of molybdenum and rhenium	Chromatographic grades also available. Supplied in Cl form
Amberlite XE-123	D	Quaternary Ammonium	19.0 kgr	140 deg F (OH form)	Uranium recovery by resin-in-pulp methods	Separation of iodide from nitrate solutions. Resin-in-pulp processes	Large particle size resin especially developed for resin-in-pulp applications. Supplied in Cl form
Amberlite IRA-401	D	Quaternary ammonium	17.5 kgr	140 deg F (OH form)	Removal of large anions from solution. Water conditioning	Separation of anionic metal complexes. Purification of non-aqueous liquids	Supplied in Cl form
Amberlite IRA-410	D	Quaternary ammonium	26.0 kgr	105 deg F (OH form)	Recovery of chromium from solution. Water conditioning	Separation of anionic metal complexes (Others similar to Amberlite IRA-400)	Supplied in Cl form
Amberlite MB-1	D	Mixture of Amberlite IR-120 and Amberlite IRA-400	9.0 kgr	140 deg F	Water conditioning, primarily for laboratory units		Amberlite IR-120 (H) Amberlite IRA-400 (OH)
Amberlite MB-3	D	Mixture of Amberlite IR-120 and Amberlite IRA-410 with indicator	11.0 kgr	105 deg F	Water conditioning, for throw-away cartridges		Amberlite IR-120 (H) Amberlite IRA-410 (OH)

‡A Chemical Processing Co. **B** National Aluminate Corp. **C** Permutit Co. **D** Rohm & Haas Co. *Preferably expressed in kilograms per cubic foot

of the resins. Poisons include: molybdates, cobaltic cyanide, silicates, polythionates and penta-valent vanadium. The first four can be washed off the resins and penta-valent vanadium can be changed into tetra-valent vanadium in the leaching process. Vanadium (IV) is not extracted by uranium-collecting resins and stays in solution.

The poisoning effect and resin losses to solution and abrasion eventually contribute to a total loss of resin. In the uranium plants, resins are expected to last about ten years. R-I-P has higher abrasion losses than the others.



(Courtesy General Refractories Co.)

Refresher on Refractories

IT'S A PRETTY GOOD BET that you cannot think of a single processed material used in civilization today, that would be available without refractories. Sociological implications aside, refractories are of primary importance to smelter men. Here are seven questions whose answers give a perspective on the use of refractories in non-ferrous smelting.

What are refractories?

Refractories are defined as "heat resistant clay and mineral products, whose prime function is to provide the structure of, or linings for, furnaces that heat, melt and generate. Broadly speaking, any material that can be heated slowly to 1,500 deg C (2,732 deg F) without showing signs of fusion, may be classified as a refractory."

What refractories are commercially available today?

More than a dozen manufacturers offer refractories of all types for use in the smelter. These companies are listed in the Buyers' Guide section of this issue. While the definition above covers a wide range of materials that could conceivably be used as refractories, economic considerations limit the number in actual service except for a few special cases. The chart above shows the key materials. The bulk of the sales are made up of the following refractories; alumina-silica, silica, magnesite, chrome and chrome-magnesite combinations.

What are the characteristics of these refractories?

Here are a few notes on the key characteristics of each of the common refractories.

Alumina-silica refractories are classified as fire clay when the alumina content is between 15 and 50%. High alumina material contains 50 to 90% alumina. In general, the higher the alumina content the higher the refractoriness. Temperature range is wide, depending on composition and there is a tendency to shrink and deform under load at temperatures well below the melting point. Resistance to thermal shock at lower temperatures is good.

High alumina brick shows good resistance to slags of a basic nature.

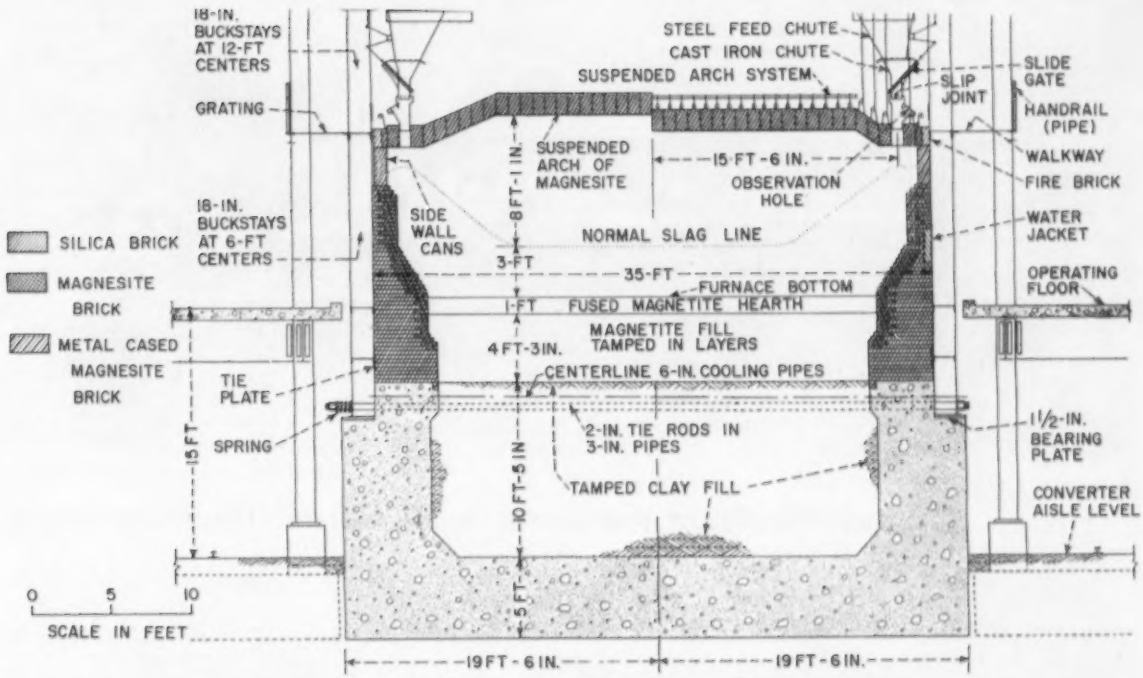
Silica refractories contain over 95% silica and exhibit greater refractoriness than fire clays. They expand at high temperatures rather than shrink, offering excellent resistance to deformation under load, even at temperatures close to the melting point. Resistance to fluxing is good but rapid temperature fluctuations under 1,000 deg F will cause spalling.

In manufacturing, about 2% lime is added to bond the silica grains, and when well burned, expansion is known and reversible and can be allowed for in jointing.

Magnesite refractories may be fire bonded or chemically bonded. Chemical bonding, it is claimed, produces a brick with much greater resistance to spalling. Basic in reaction, magnesite exhibits more refractoriness than silica. It shows better resistance to chemical attack by slags and metallic oxides, particularly iron oxide. It has a tendency to shrink and spall at high temperatures. Cost of chemically bonded magnesite brick is much greater than that of silica, with fire bonded brick slightly less expensive.

In making magnesite brick, ore is dead burned at temperatures above 2,700 deg F. About 50% contraction occurs and burning must be thorough to prevent further contraction in service. To make a dense brick, particle size and screen analysis must be carefully controlled.

Chrome refractories show poor resistance to iron oxide but don't shrink like magnesite. Ability to carry loads at high temperatures is poor and a strong tendency exists to spall if temperature fluctuates rapidly. Chrome brick costs about 30% less than magnesite.



NEWEST REVERBERATORY smelter in the United States went on stream early this year at the property of the San Manuel Copper Corp. in Arizona. Cross-section of furnace shows where and how different refractories are used.

Chrome and magnesite are frequently mixed to form refractories combining the desired features of each.

How are refractories selected?

Selecting refractories is virtually a personal business. Almost any variation in composition is available on the market, and manufacturers will vary composition within the market grades to produce a satisfactory product for you. There is, for example, a whole range of magnesite-chrome and chrome-magnesite brick to choose from. Even grain size is sometimes varied for special requirements. Bricks may be furnished in cans for easy installation or clad in steel to reduce spalling and simplify installation.

To see where and how refractories are being applied in non-ferrous smelting, turn to page 138.

Is special handling needed for refractories?

Carelessness in handling and storing refractories costs a lot of money. Impress your employees with how expensive they are. Some cost saving hints are:

1. Avoid unnecessary handling that may damage corners and edges.
2. Use rubber-tired wheelbarrows and well sprung carts for moving by hand; power lift trucks for handling loads on pallets.
3. Store in dry shed, preferably with concrete floor and no danger of flooding.
4. Do not stack brick too high.
5. Store refractory mortars in heated areas.
6. Stack brick on edge with laths in horizontal joints.
7. Have all workers wear gloves and give prompt medical attention to cuts and abrasions from firebrick.

How can the life of refractories be extended?

Where possible in furnace design, avoid having brickwork exposed to high temperatures on two sides.

Don't let burner flame impinge on refractories.

When burners are too close to side walls, refractories are subject to localized high temperatures and often to fluxing action of fuel ash. A thin coating of bonding mortar will help protect these walls.

Life of the roof of the combustion chamber often can be extended by raising its height above the grate.

High walls should always be anchored.

If you change fuels, be sure you check the effect of the new fuel on your refractories. It makes a difference.

Avoid rapid changes in temperature to prevent spalling.

Where two refractories, which will react chemically with each other at high temperatures, are used in adjacent sections of the furnace, separate them by an intermediate course of brick that will not react with either.

Charge the furnace carefully and avoid damaging the walls when stirring bath or when cleaning the hearth.

Where possible use brick in compression not tension.

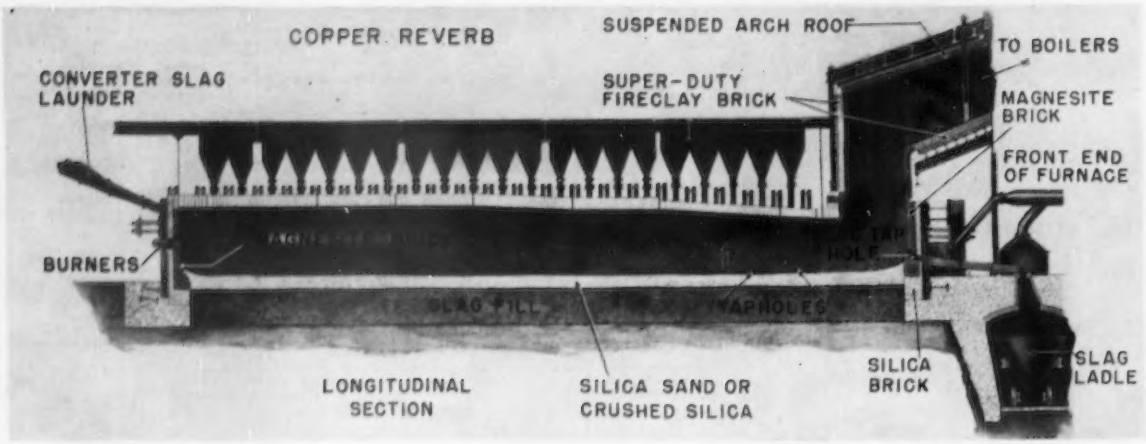
When insulating, study carefully the savings of increased refractory life versus lower heat losses.

Where can I learn more about refractories?

This has been just a bird's eye view of refractories and the job they do. For full details plus information on construction with refractories, design, shapes available and a variety of other useful facts, two excellent catalogs have been put out by manufacturers. "Refractories" issued by General Refractories Co., and "Modern Refractory Practice," published by Harbison-Walker Co. Both addresses are listed in the Buyers' Guide in this issue.

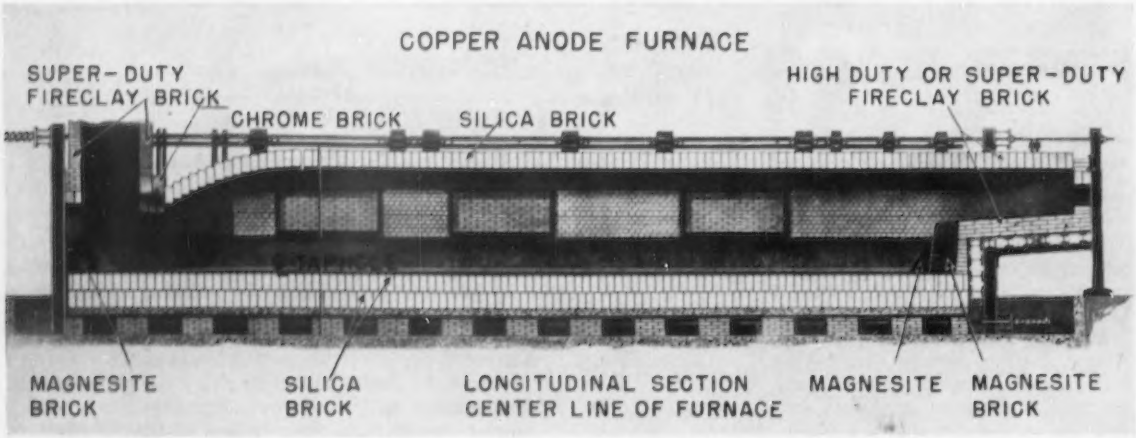
An excellent text book on the subject covering scientific details is the 782-page "Refractories" by F. H. Norton, published by McGraw-Hill Book Co.

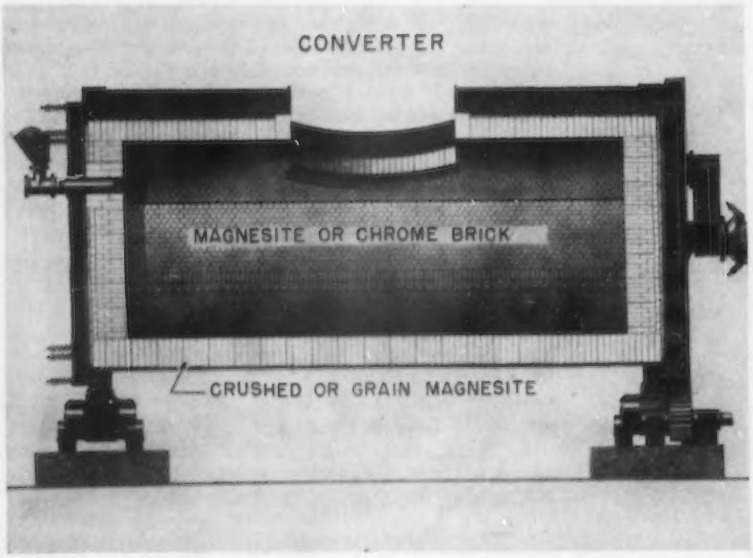
For refractory applications, please turn page

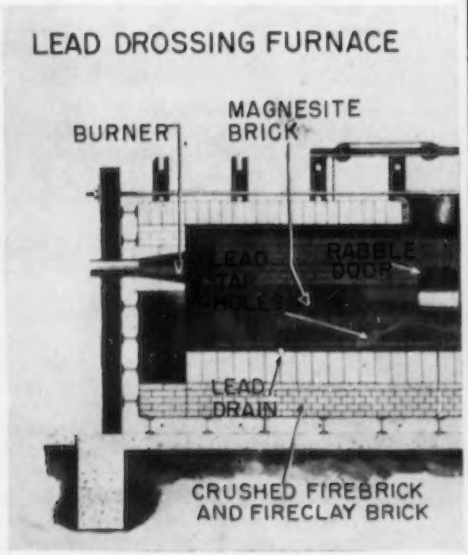


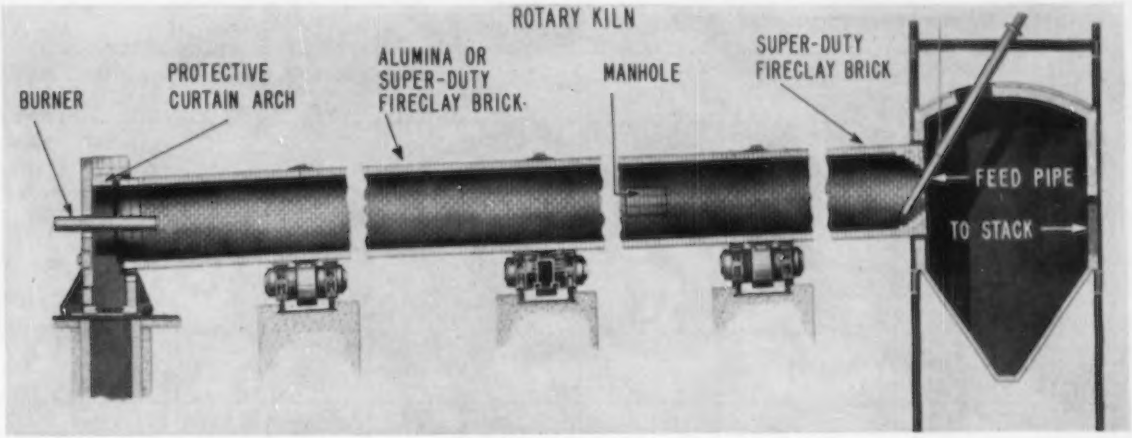
All drawings courtesy Harbison-Walker Refractories Co.

What refractory should be used where? Here are some

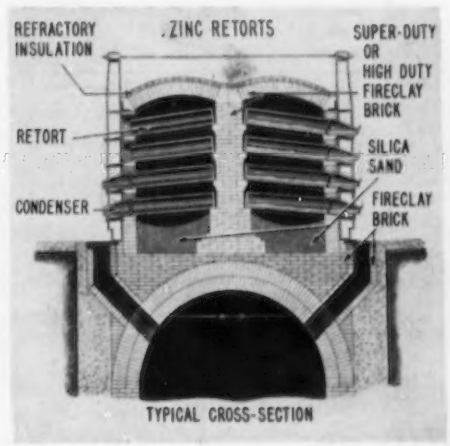


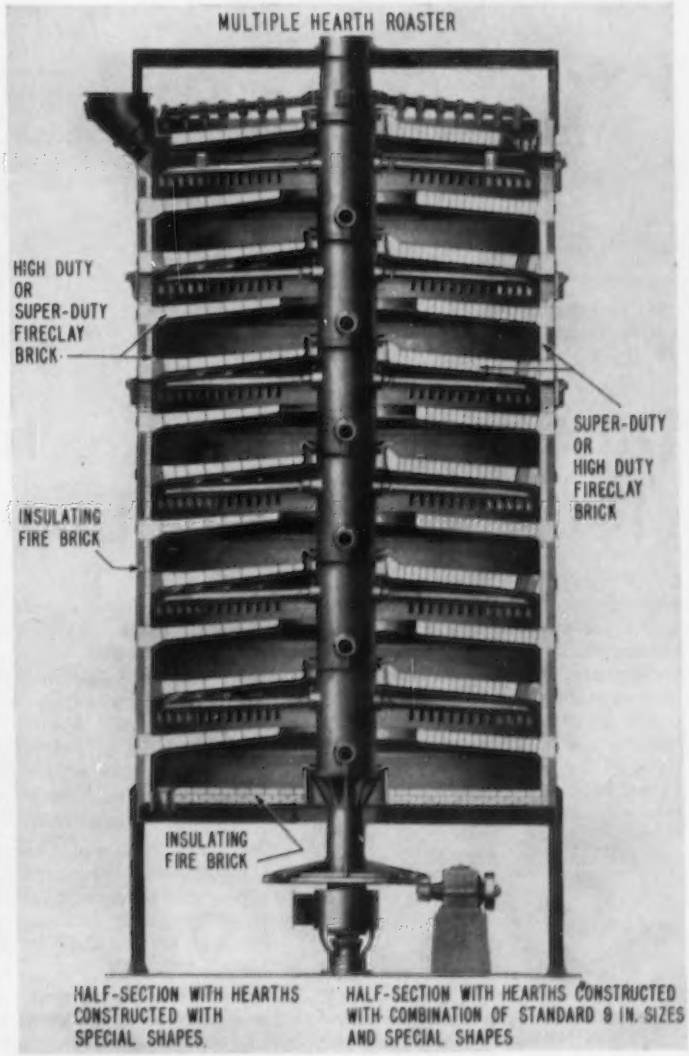


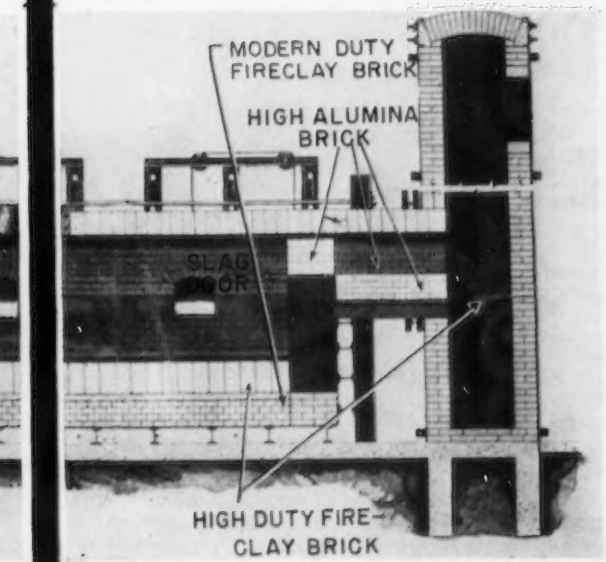




important applications for non-ferrous smelter men




MULTIPLE HEARTH ROASTER
HIGH DUTY OR SUPER-DUTY FIRECLAY BRICK
SUPER-DUTY OR HIGH DUTY FIRECLAY BRICK
INSULATING FIRE BRICK
INSULATING FIRE BRICK
HALF-SECTION WITH HEARTHS CONSTRUCTED WITH SPECIAL SHAPES
HALF-SECTION WITH HEARTHS CONSTRUCTED WITH COMBINATION OF STANDARD 9 IN. SIZES AND SPECIAL SHAPES



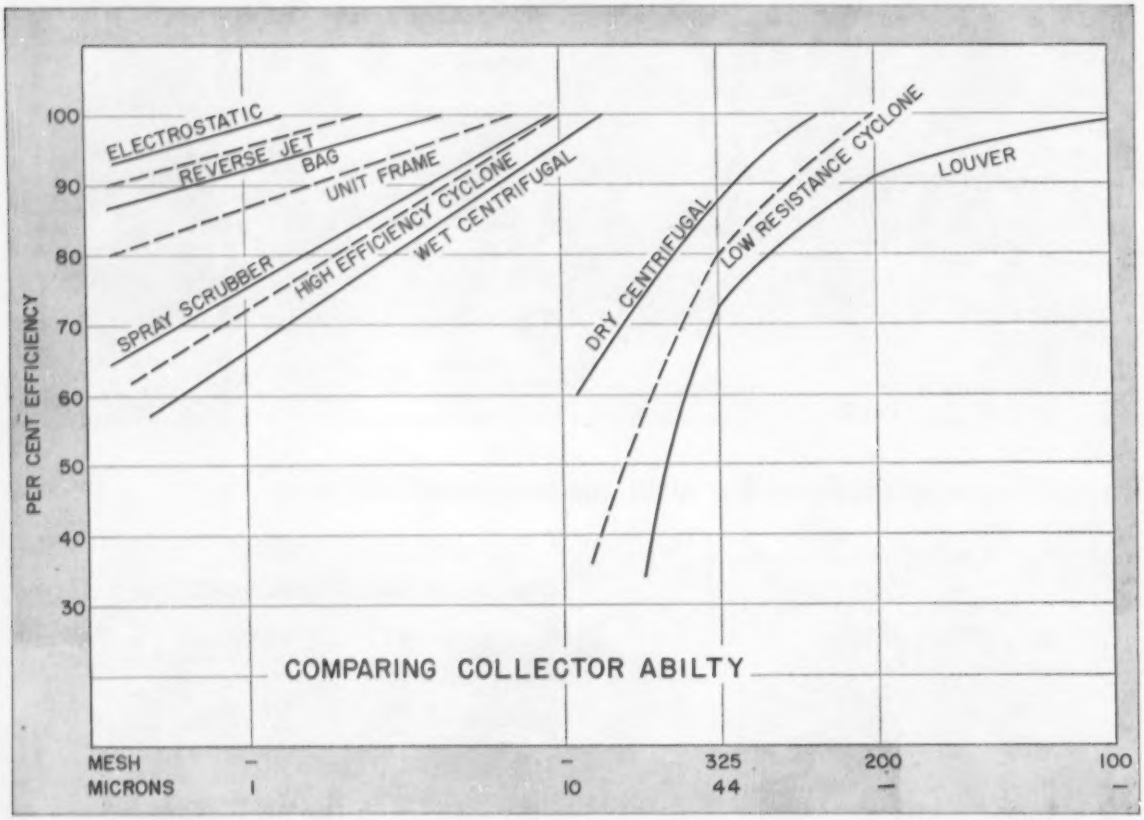


CHART SHOWS THAT in micron range, efficient collecting can be accomplished with wet scrubbers, high efficiency cyclones, fabric arrestors and electrostatic precipitators. On the plus 325 mesh sizes, the centrifugals make good scalping units.

Dust and Fume Collecting— Misfit Installations Unnecessary

NO MATTER WHAT REASON COMPELS YOU to select or design a collecting system, misfit installations are most unnecessary. Misfits cost money, not only in original capital costs; but also in lost income, lost time, lost operating costs and the eventual replacement of the misfit.

We have listed below the things you will have to know to make the proper collector choice. No single collector can do everything, so we have listed the types of collectors available, what they can do, what they can't.

In choosing the right collector system to fit your problem, you will have to have information on the following items: dust characteristics; gas characteristics; efficiency requirements; initial cost restrictions; operating cost restrictions; space limitations; and draft-loss limitations.

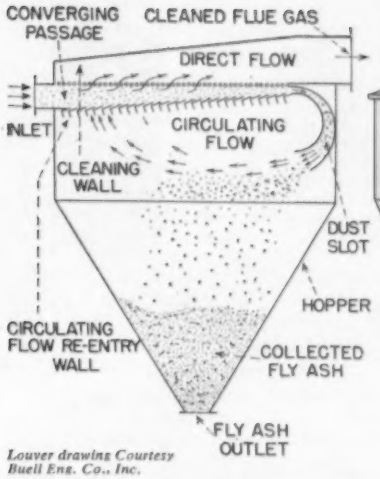
Dust characteristics include its source, chemical nature, size and size distribution, specific gravity, shape, loading, disposability, wetability, corrosive nature, erosive nature, resistivity, stickiness, hydroscopic nature, combustibility and its value.

Gas characteristics can be evaluated by knowing the quantity, temperature, pressure, chemical nature, dew point, moisture content, combustibility and corrosive nature of the dust-bearing stream.

Efficiency is determined by the value of the dust or fumes to be collected, process demands, dust concentration, anti-dust ordinances and air pollution controls.

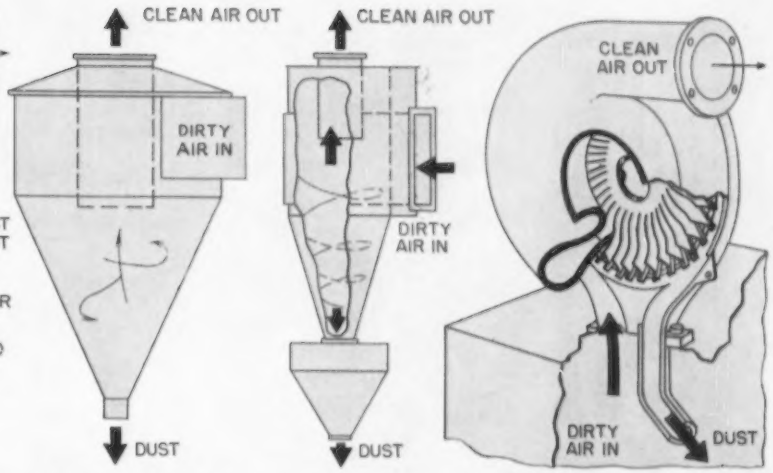
Initial cost and operating cost go hand in hand. Determine how much you can spend for a system and how much you can afford to spend operating the equipment; then judge the merits of a system on an over-all cost picture. A unit that has a low initial cost may have a high operating and maintenance cost, and vice versa. Operating costs should include parts, auxiliaries, labor, down-time and power consumpion.

Space limitations are not too important in a new project. The best collector can be chosen and the building designed to house that choice. But, on a remodeling or ex-



Louver drawing Courtesy Buell Eng. Co., Inc.

SCALPING heavy dust particles can be done with low-cost louver-type collectors.



CENTRIFUGAL FORCE, employed by low resistance cyclones, high efficiency cyclones and centrifugal fan collectors, is effective on plus 325 mesh dust particles.

pansion job, lack of space may eliminate a large, bulky collector.

Draft-loss limitations on a smelter installation, or in an air concentrating project may eliminate highly efficient collectors such as the bag collector.

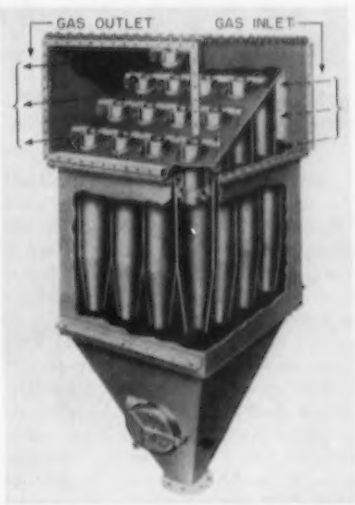
In choosing your collector systems, think about combinations. Maybe a scalping collector will help you cut operating and maintenance costs on the final collector. It might save you some space and it can increase the efficiency of the operation.

The types of collectors available, going from the simplest and therefore the least expensive and the least efficient, to the complex electrostatic precipitators, will be considered.

Drop It Out

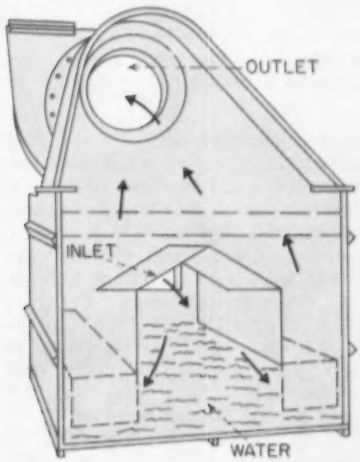
In the past, attempts have been made to collect air-borne dust by sealing off an area in the plant and blowing the dusty air into that space. Dust could be dropped out of the air, since the velocity of the gas dropped when the stream entered the large room from a narrow pipe. To get the air out of the room, large unit-frame filter windows were provided. The system was not too practical in that it required lots of space, was difficult to keep air-tight and expensive to maintain the unit-frames.

The louver collector is a small, compact collector that operates on the drop-in-velocity principle employed in the old drop-out rooms. They are used to collect fly ash and heavy dust. These low cost units have no moving parts, can work under high pressures, at high feed rates and are generally used as a scalping collector.



(Courtesy Western Precipitation Corp.)

MULTICLONE type of high efficiency cyclone can be very effective on fine dust.



WET SCRUBBERS eliminate corrosives, cool gases and collect much fine dust.

Dust enters the louver unit between two rows of open slats. Clean gas passes upward through the slats and out of the system. Dust drops out of the gas and falls down through the lower row of slats and into a hopper. No air-lock is needed to discharge from the hopper. Water may be used to aid hopper discharge.

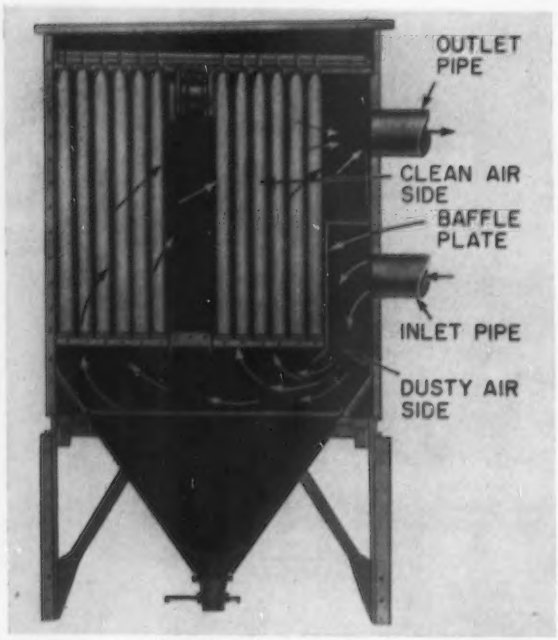
Louver design has large surge capacity. On boiler fly ash, this collector will collect 99% of all plus 100 mesh. On dust at 2.0 specific gravity, it will collect 92% of all 200 mesh; 75% of all 325; and 32% of all 20 micron particles. It can be obtained in sizes from 4,000 to 46,700 cfm capacity.

Throw It Out

Cyclones and mechanical separators employ centrifugal forces to throw the dust out of a gas stream. Cyclones are available in either low resistance or high efficiency designs.

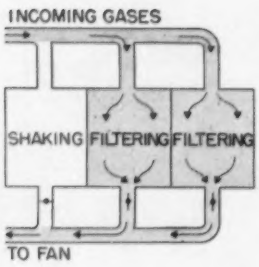
Low resistance cyclones are mostly used to scalp heavy dust loads, but can be used as final collectors in isolated areas or when provided with water sprays. Construction and maintenance costs are low. They can be operated at high temperatures. In non-corrosive and non-erosive conditions, a well built low efficiency cyclone can last 20 years or more.

High efficiency cyclone can be

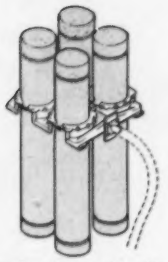


(Courtesy American Wheelabrator & Equipment Corp.)

FABRIC COLLECTORS are the choice of many smelter operators to collect dust and fumes. Many designs available.

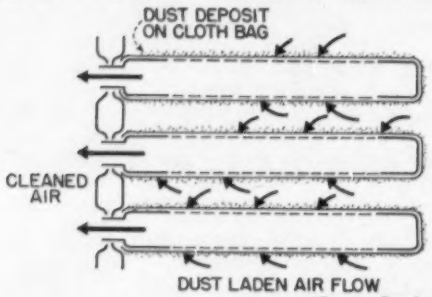


SHAKER design alternates compartments on cleaning.



(Courtesy Koppers Co., Inc.)

REVERSE-JET removes dust with blow-back rings.



(Courtesy Pangborn Corp.)

SCREEN CLOTH fabric collector gathers dust on outside of the sock. It can be intermittent or continuous blow-back.

used as a scalping device or as a final collector. Collecting efficiencies are very good; up to 100% at 10 microns or larger. In the 1 to 2 micron range, efficiencies as high as 99% have been reported. These small diameter cyclones work well on either high or low loading conditions. Collector efficiencies up to 95% have been reported where only 3 grains per cu ft dust were present. Normally, the smaller the cyclone diameter, the more efficient the unit becomes.

Many cyclones are locally fabricated. Modern designs have produced a very good, low cost, low maintenance unit.

Large part of the cost of a single unit, high efficiency cyclone is borne by the hopper outlet used to unload the hopper. Several discharge mechanisms are available; the star valve being the most expensive to install. Star valves, including motor and speed reducer, can cost as much as $900 each.

The Multiclone is a high efficiency cyclone with a unique design. The gas stream enters the outside top and leaves through the inside top, while in the conventional cyclone the gas enters at the side. It has very high efficiency and is used in combination with electrostatic collectors on smelter operations. Its efficiency compares or exceeds the conventional high efficiency cyclone.

Dry centrifugal collectors are their own draft inducing unit. They rank below high efficiency cyclones in efficiency and above cyclones in operating costs. They are not much good below 20 microns. They are used as primary collectors or scalpers.

This collector has a material handling fan that collects dust as it rotates at high speed. The dust travels to the central shaft of the fan and passes out of the collector. Fan is subject to rapid abrasion on heavy loading applications. It tends to plug on moist material; but like the cyclone, it can be used at high temperatures.

German model of this design runs at high speed while collecting; then automatically slows down at predetermined dust load, to discharge the dust to a spiral conveyor in the central shaft. Five fans are used in a housing, alternating on unloading cycle.

Wash It Out

All wet collectors deteriorate rapidly on gas systems containing sulphur compounds; unless non-corrosive construction is employed. Big advantage in a wet collector is that it will remove corrosive elements from the gas, that would ordinarily corrode and ruin nearby process equipment. Many types of wet collectors have been developed. Freezing in winter can be a problem.

Wet cyclone can be made by adding spray lines and a waste steam line to a low resistance cyclone. This unit will knock down a surprising amount of minus 10 micron particles. Waste steam line seems to help out by thoroughly wetting down the particles. One of the best spray nozzles is a flat-fan, 80 degree angle, agricultural insecticide spray nozzle, which can be purchased from any farm equipment supplier.

Wet centrifugal collector can be made by adding sprays to a dry centrifugal. Like the wet cyclone, the wet centrifugal ranks slightly above its dry parent in collector efficiency. This wet collector is somewhat more expensive to maintain, due to corrosion.

Baffle-box scrubber works by pulling dust and gas under a baffle and up through several inches of very turbulent water. Very efficient dust collecting can be maintained with this unit, although it is subject to freezing in winter. Corrosion is a problem. It takes up little space in the plant. Unit will handle hot dusts and fumes and should be considered whenever the reclaimed material can go directly to flotation. Baffles can handle up to 1,000 cfm per foot baffle length. Foaming and mist formation can cause trouble. If exit air is to be reused, it must be filtered through a unit frame filter to take out mist. Maintenance costs seldom exceed 10 to 15% of installed cost a year.

Spray towers are similar to wet cyclones, in that sprays are fitted around the inside of a tall tank and knock down the dust as the gas passes upward through the tank. Baffles are usually spaced throughout the tank to help in cleaning the gas. This unit would have to rank below a wet cyclone in efficiency and would work best as a gas-cooling and dust-scalping unit ahead of a bag house.

Venturi scrubber uses fast moving water to suck up dusty air. Venturi is very efficient in removing dust and corrosive gases, but requires plenty of available water.

Filter It Out

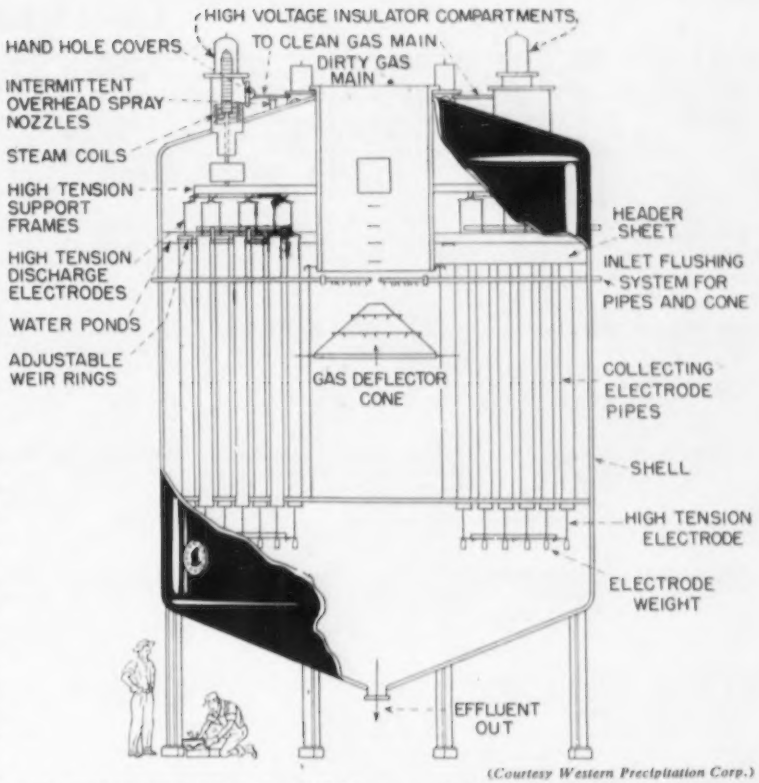
While the wet collectors mentioned above can cause modest draft losses in a system, the fabric collectors are even more subject to draft losses. Fabric filter can be a unit frame, a bag filter or reverse-jet bag filter. These types are very efficient, even in the 1 to 2 micron range.

Unit frame filters are available in two designs. One type uses disposable cloth, which is held in a frame in the system. When dirty it is replaced with fresh material. Disposable unit gets to be pretty expensive in heavy loading conditions and is generally used only to clean process air or for ventilation purposes. Second design in unit frames has a self-cleaning system, which can be either wet or dry, continuous or semi-continuous. It is used in same circumstances as the disposable.

Shaker discharge unit pulls air and dust into the bottom of a number of glass wool, Orlon or wool socks. Dust is collected on the inside of the sock, while the cleaned gas passes through the sock and escapes. Collector must stop collecting to unload dust by a rapper or shaker device. This design is used in multiples, so that when one compartment is unloading, the rest are collecting. Rotation of discharge cycle is automatic. Maintenance cost is mostly bag replacement. Shaker design cannot operate at high feed rates as in the reverse-jet collector.

Screen cloth fabric collector is a refinement of the fabric collector. The fabric is stretched over wire mesh frame. Dust is collected on the outside of the fabrics, clean air passing on through the material. Discharge into hopper below is by rapper, shaker or blow-back. Intermittent units, like the shaker baghouse, use rapper or shaker to unload. Continuous units employ reverse air blow-back from inside the frames.

Small, compact units with up to 1,000-sq ft cloth area are available. Large, bulky units up to 16x40-ft size can handle 40,000 cfm through about 11,000-sq ft cloth. Intermittent collectors handle 2 to 4 cfm per sq ft cloth, while reverse-jet or continuous blow-back can operate at 5 to 10 times as high.



(Courtesy Western Precipitation Corp.)

ELECTROSTATIC PRECIPITATORS represent the most complicated, expensive and efficient dust and fume collector available today. Smelters rely on them heavily.

Reverse-jet is a bag collector not much different from the shaker, except the shaker is replaced by traveling hollow rings that move up and down the outside of the socks. These rings continually blow a jet of air back through the sock, freeing the dust which falls down into the hopper below. Rotating compartments are not required and the reverse jet can handle 5 to 10 times the velocity suited for the shaker. Up to 20 cfm per sq ft sock area is possible in the reverse-jet.

These three baghouse collctors can be operated in systems with temperatures up to 285 deg F. When used on smelter or foundry equipment, a cooling tower must be used ahead of the fabric collector. In one grey-iron cupola installation, a five-compartment shaker collector treats 16,900 cfm, at 285 deg F. Gas is cooled from 1,400 to 285 deg F in cooling spray collectors. Orlon is the best fabric for sock material.

Electrostatic precipitators employ a source of high-voltage dc current; a grounded metal tube; a wire mounted within the tube to which a negative polarity current is applied; a gas inlet and outlet; and a hopper to collect dust displaced from the electrodes.

When dust particles enter the chamber, they become negatively charged and are diverted out of the gas stream toward the collecting electrode. Clean gas passes out of the collector. A rapper or shaker knocks down the dust continually. When dust is sticky, a wet spray is used to unload the hopper. Gas temperature must be high enough to prevent condensation, low enough to prevent melting of electrode elements (up to 550 deg F). This collector is almost universally employed in the lead-zinc smelting industry. Efficiencies up to 99% are reported. Most units have a scalping collector ahead of the precipitator.

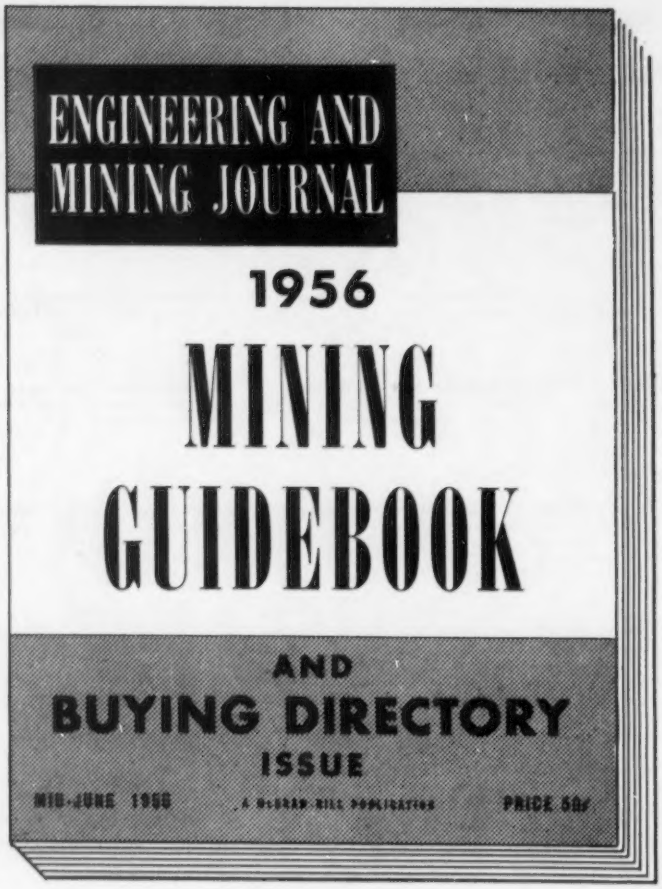
Disadvantages are that the precipitator must have low gas velocity, electrodes must be properly spaced, unit must be protected to keep employees away from high voltage. On the next two pages all the types are compared.

Use This Check Chart to Narrow

Collector types	DUST CHARACTERISTICS: Chemical nature	Particle size range	Specific gravity	Particle shape	Dust load	Wettability and disposability	Dust value
Louvers	No problem	30 microns and up, but coarse sizes abrade slats	Heavier the gravity the better the collector	Flaky material sails out. Sharp edges increase slat abrasion rate	Can handle a large surge load, but high load increases slat abrasion	No problem. Dry collecting. Wet or dry discharge	Cannot be used if dust has any value. No good on fumes
Low resistance cyclone	No problem	20 microns and up. Works best on plus 200 mesh	Heavier the gravity the better	Flaky material sails out	Can handle light or heavy loads	No problem. Dry collecting and discharging	Cannot be used if dust has any value. No good on fumes
High efficiency cyclone	No problem	1 micron and up, but better on plus 10 microns	No problem	Sharp particles abrade inlet face	Can handle as little as 3 grains per cu ft. Higher the dust load the better it works	Dry collecting. Dry discharge must flow out of air lock	Is used to concentrate, size and collect valuable materials. No good on fumes
Dry centrifugal	No problem	10 microns and up, but best on plus 200 mesh. Too much coarse will cause high fan abrasion	Heavier the better	Sharp particles abrade fan	Heavy dust loads increase abrasion rate on fan	No problem. Dry collecting and discharging	Has been used to concentrate, size and collect valuable dusts. No good on fumes
Wet centrifugal	Sulphur compounds cause corrosion	All sizes, but coarse abrades fan	No problem	Sharp particles abrade fan	Can handle light or heavy load, but heavy load increases fan abrasion rate	Dust must be wettable. Wet collecting and discharging	Can be used to collect valuable dust, if discharge can go to process or thickener
Wet cyclone	Sulphur compounds cause corrosion	All sizes	No problem	Sharp particles abrade inlet	Can handle light or heavy loads	Must be wettable. Wet collecting and discharge	Can be used to collect valuable dust, if discharge can go to process
Wet scrubber	Sulphur compounds corrode	All sizes	No problem	No problem. Abrasion slight	Can handle heavy loads, but tank water must be changed oftener	Must be wettable. Wet collecting and discharge	Can be used to collect valuable dust, if discharge can go to process
Spray tower	Sulphur compounds corrode	All sizes	No problem	No problem	No problem	Must be wettable. Wet collecting and discharge	Can be used to collect valuable dust, if discharge can go to process
Venturi scrubber	Sulphur compounds corrode	All sizes, but excess coarse causes rapid abrasion of mixing chamber	No problem	Sharp particles abrade mixing chamber	Heavy dust loads increase chamber abrasion rate	Must be wettable. Wet collecting and discharge	Can be used to collect valuables if large water rate can be tolerated
Unit frame filter	No problem	Designed for minus 200 mesh or smaller	No problem	No problem	Not designed for heavy loads. Use as ventilation filter	Dry collecting on disposable unit. Wet or dry on self-cleaning	Not designed to collect valuable material. Use to ventilate or clean process air
Fabric filter	No problem	Designed for minus 200 mesh or smaller	No problem	Sharp particles can abrade filter cloth	Not designed for extremely heavy loads. Use scalping unit ahead	Dry collecting and dry discharge	Used to collect valuable dust and fumes in smelters
Reverse jet filter	No problem	Designed for minus 200 mesh or smaller	No problem	Sharp particles can abrade filter cloth	Not designed for extremely heavy loads. Needs scalping unit	Dry collecting and dry discharge	Used to collect valuable dust and fumes in smelters
Electrostatic precipitator	No problem	Designed for very fine particles and fumes	No problem	Sharp particles can abrade collector elements	Works best on light dust loads. Can be used on heavy. Needs scalping unit	Dry collecting and dry discharge	Used to collect valuable dust and fumes

Down the Collector Search

Collector types	GAS CHARACTERISTICS				DESIGN CHARACTERISTICS		
	Temperature deg F	Chemical nature	Pressure and draft loss	Dew point and moisture	Efficiency	Initial cost and operating cost	Space limitations
Louvers	Can operate up to 1500	No problem	Low or high pressure unit. Very little draft loss	No problem, but if wet it can corrode	Good on fly ash and heavy dust. 99% on plus 100 mesh. 32% on all plus 20 microns	About the lowest cost unit. No moving parts. Low operating cost. Maintenance should be no more than 5% of installed cost per year	Small compact unit.
Low resistance cyclone	Can operate up to 1500	No problem	Low pressure unit. Low draft loss	No problem, but if wet it can corrode	Good on fly ash and heavy dust. 75% on all plus 325 mesh	Low cost unit to install and operate. Maintenance costs very low	Takes up considerable space. Usually placed outdoors
High efficiency cyclone	Can operate up to 1500	No problem	Low or high pressure unit. Some draft loss encountered	No problem, but if wet it can corrode	If there is not too much 1 micron dust, it can hit 95%. Suitable for plus 10 micron feed	Can be made for about $1,000 or less in stainless steel. Maintenance costs about 5% installed cost per year. No moving parts	Generally small and compact. Must not change direction of gas flow too rapidly
Dry centrifugal	Can operate up to 1500	No problem	Fan induces its own draft	No problem, but if wet it can corrode	Good on plus 325 mesh. Poor on minus 10 microns	Cost about the same as cyclone, since it must have motor for fan. Maintenance cost about 10% installed cost a year	Very small and compact
Wet centrifugal	Can operate up to 1500. If corrosives present, it will corrode faster at high temperatures	Sulphur compounds corrode. Good collector to remove corrosives from air	Fan induces its own draft, but somewhat less than dry centrifugal	No problem	Good on plus 10 microns. 80% in 1 to 10 micron range. Good on corrosive gas	Cost about same as cyclone. Maintenance costs run 10–15% installed cost per year	Very small and compact
Wet cyclone	Can be used up to 1500. If corrosives present, it will corrode faster at high temperatures	Sulphur compounds will corrode. Good collector to remove corrosives	Low pressure unit. Low draft loss	No problem	Good on plus 10 microns and corrosive gas. 80% in 1 to 10 micron range	Cost about same as low resistance cyclone. Maintenance cost about 10–15% of installed cost per year	Same size as low resistance cyclone
Wet scrubber	Can operate up to 1500. If corrosives present, it will corrode faster at high temperature	Sulphur compounds will corrode. Good collector to remove corrosives	Gas must be pulled through several inches of water. Some draft loss	No problem	Good on plus 10 microns and corrosive gas. 80% in 1 to 10 micron range	Cost about same as louver. Maintenance cost 10–15% of installed cost per year	About the size of a louver
Spray tower	Can be used up to 1500. If corrosives present, it will corrode faster at high temperature	Sulphur compounds will corrode. Good collector to remove corrosives	High or low pressure unit. Only slight draft loss	No problem	Good on plus 10 microns and corrosive gas. 80% in 1 to 10 micron range	Cost about as much as a steel tank. Maintenance cost 10–15% of installed cost per year	A steel tank can be used.
Wet venturi scrubber	Can operate at up to 1500. If corrosives present, it will corrode faster at higher temperature	Sulphur compounds will corrode. Good collector to remove corrosives	Low pressure unit. Venturi is its own draft inducing mechanism	No problem	Good on plus 10 microns and corrosive gas. 80% in 1 to 10 micron range	Very low cost, but needs water pump and water supply. Maintenance cost about 10–15% of installed cost per year	Small and very compact
Unit Frame filter	With Orlon filter can stand 285; with wool 225; with cotton, 175	Orlon will resist most chemicals. Glass and wool available	Some pressure rise encountered since air must pass through filter. Must have positive pressure	Must not condense in unit. Moisture will blind cloth. No problem on wet self-cleaning unit	Good on plus 10 microns. 80% in 1 to 10 micron range	Too expensive to use as dust collector. Good for process air or ventilation. On disposable unit replacement cost can get high if much dust is present	Small to medium size
Fabric filter	With Orlon filter can stand 285. Use wet collector ahead to scalp and cool gases	Orlon can resist most chemicals. Glass and wool available	Some back pressure may be encountered since gas must pass through fabric	Must not condense in unit. Moisture will blind fabric	Up to 100% in the minus 10 micron range. Good on fumes	A five compartment unit costs upwards of $30,000 installed. Maintenance cost is low, mostly bag replacement	Large and sometimes bulky unit up to 16 x 40-ft
Reverse jet filter	With Orlon filter can stand up to 285. Use wet collector ahead to scalp and cool	Orlon can resist most chemicals. Glass and wool available	Can be operated at higher pressures than shaker design. Up to 5 times more pressure permitted	Must not condense in unit. Moisture will blind fabric	Up to 100% in the minus 10 micron range. Good on fumes	Slightly more expensive than shaker, but smaller. Maintenance cost, not much more than shaker	Smaller than shaker baghouse
Electrostatic precipitator	Can operate up to 550	Must not contain compounds that attack elements	Not much pressure drop	Must not condense in unit	The most efficient collector yet designed for very fine dust and fumes	The most expensive collector to install. Requires high voltage rectifier. Maintenance cost about 10% of installed cost per year	Smaller than a baghouse



To the people who made this Mining Guidebook possible . . . .

. . . To the companies who furnish the mining industry with essential equipment, services and supplies;

To the mining companies and their personnel;

To the men of the Bureau of Mines, the Geological Survey and the Atomic Energy Commission;

To the mining schools and technical consultants;

The editors of *Engineering and Mining Journal* are deeply and humbly grateful for their generous contributions of knowledge, experience and material. Through interviews and field trips by the dozen, and through letters and questionnaires by the hundreds, their advice and cooperation have been the backbone of this Guidebook.

NEW International® Payhaulers

for years a leader in the manufacture of heavy-duty construction equipment, International now offers you the same fine engineering and rugged dependability in

OFF-HIGHWAY HAULERS

MODEL **95** 24 TONS

TWO **ALL NEW** MODELS

MODEL **65** 18 TONS

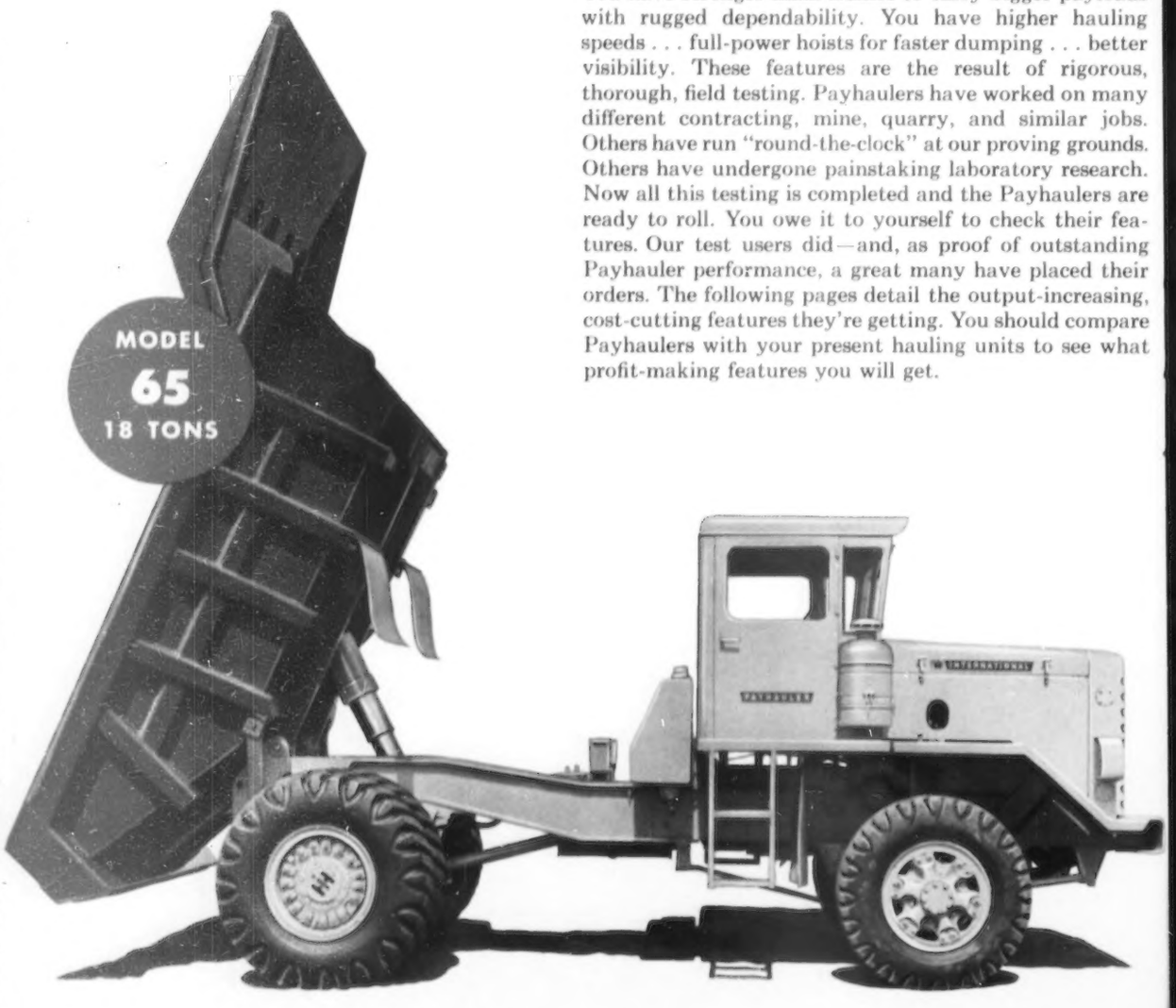
NEW RUGGEDNESS - POWER - COMFORT - ECONOMY

Announcing the NEW Internat

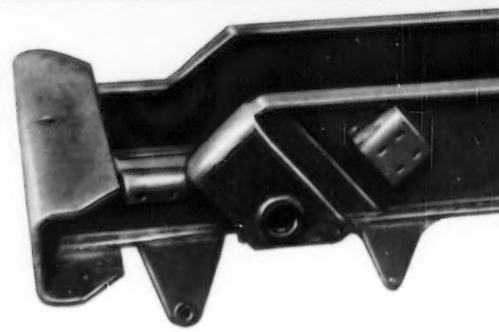
Designed with features you asked for

250-335 HP Turbo-Charged Diesel Engines
Rugged, Welded, All-Steel Frame
Full-Floating Axles Planetary Drive
Speeds to 38 MPH
Power Shift Transmission

Hundreds of contractors, mine owners, quarry operators, and other equipment users told our engineers what they needed in an off-highway hauler. Their suggested design features have been carefully built into the new International Payhaulers. In these rugged, all-new, rear-dump haulers, you have greater horsepower-to-payload weight ratios than are available in most other off-highway trucks. You have stronger main frames to carry bigger payloads with rugged dependability. You have higher hauling speeds . . . full-power hoists for faster dumping . . . better visibility. These features are the result of rigorous, thorough, field testing. Payhaulers have worked on many different contracting, mine, quarry, and similar jobs. Others have run "round-the-clock" at our proving grounds. Others have undergone painstaking laboratory research. Now all this testing is completed and the Payhaulers are ready to roll. You owe it to yourself to check their features. Our test users did—and, as proof of outstanding Payhauler performance, a great many have placed their orders. The following pages detail the output-increasing, cost-cutting features they're getting. You should compare Payhaulers with your present hauling units to see what profit-making features you will get.



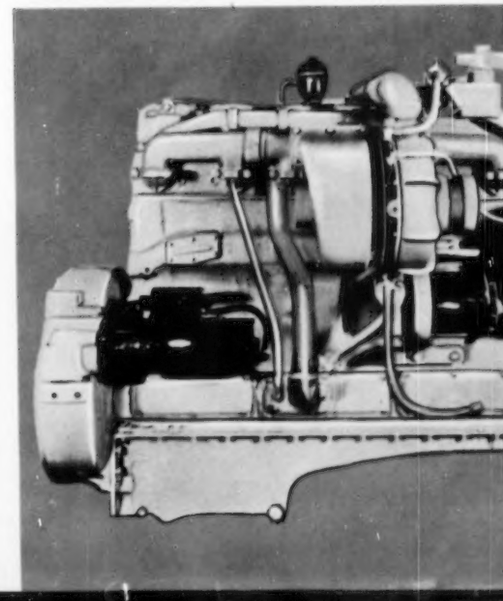
Rock-rugge



Rugged Frame. Built of heavy-duty welded and convention with web thicknesses of ½ and ¾ inches, Payhauler main fra strongest section modulus known of any off-highway truck. Re tion of rolled "I" beams is held rigid by tubular torque and h members. Front frame sections flex with shock loads thro bumper torque member.

Free-Floating Springs. *From the ground up, Payhauler strength for outstanding performance on rugged jobs.* Semi-el leaf, free-floating springs effectively "swallow" the shocks of big shovels and of high-speed hauling over rough ground. radius rods keep springs and axles in position.

Pay-off powe



ational® Payhaulers

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Sturdy Axles. Durable axles help Payhaulers carry 36,000 to 48,000 lbs. smoothly, comfortably at speeds up to 38 mph. Note the massive differential housing with in-built spring mounting pads. Heavy-duty, rear axle housing tial to provide top load carrying capa equally sturdy—of forged or tubular de

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Payhaulers pack extra
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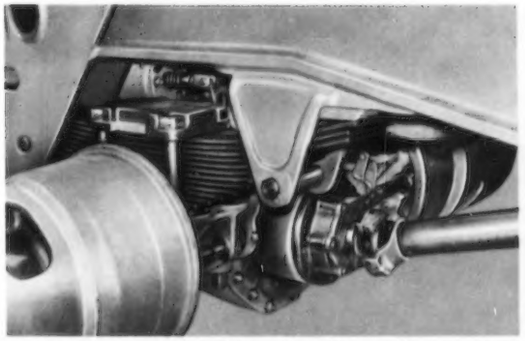

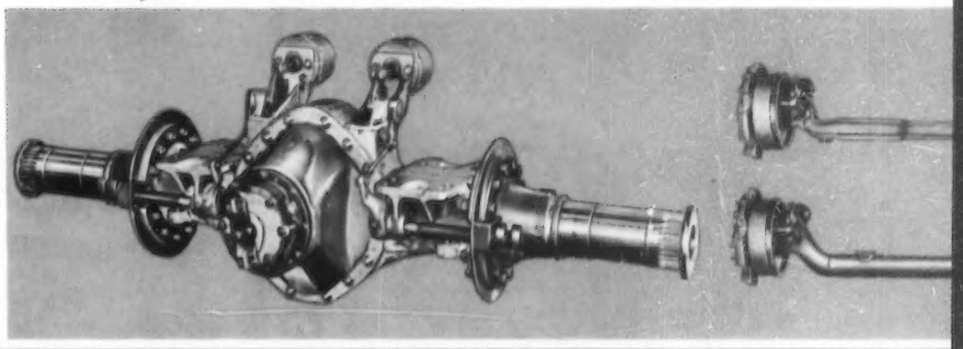

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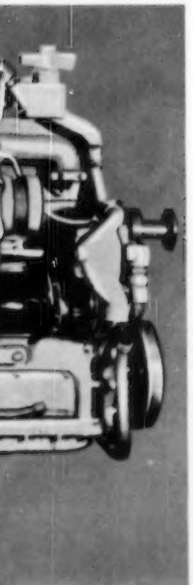

Both the "65" and "95" Payhaulers have more horsepower per struck yard than any other truck in their size class. The 24-ton, 16-yard "95" is powered by a 335 hp diesel . . . the 18-ton, 12-yard "65" is powered by 250 hp engine. Turbo-charging keeps power high, weight low, reduces fuel consumption 10% or more. Large radiator (below) with 1425 sq. in. of area plus powerful 32-inch fan insure proper engine cooling under all job conditions. Suspended on four large rubber mounting pads, the Payhauler radiator is protected against shock.

Cerametallic Clutch. In g
metallic clutch facings virtually
This clutch, made of heat-d
fewer adjustments, gives long
than any other clutch in the

Torque Converter. The 24-ton Model 95 Payhauler is available with a 4-speed Torque Converter transmission for smooth speed changes from 4.8 to 38 mph. A lock-up clutch for direct drive performance and a Torqmatic brake system are standard with the versatile Torqmatic transmission. No other truck provides these features as standard equipment.

Conventional Transmission. You have a choice in the "65" Payhauler of a 5 or 10-speed geared transmission to fit job conditions—speed ranges are from 3.5 mph to 36.5 mph for either. In the "95" Payhauler, a 9-speed transmission provides an excellent range of speeds from 2.6 to 37.2 mph. Operators especially like the single lever air-assisted shift control.

Planetary Fi
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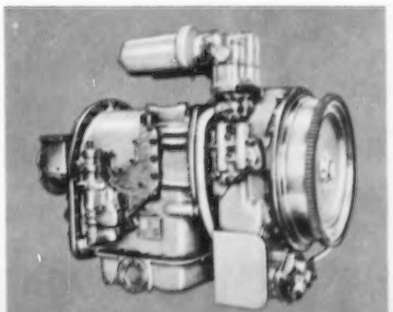
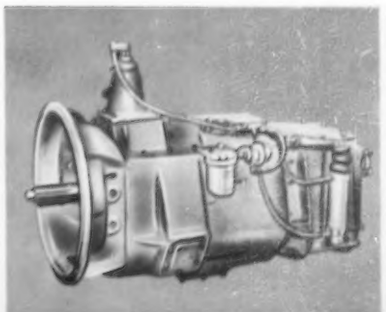
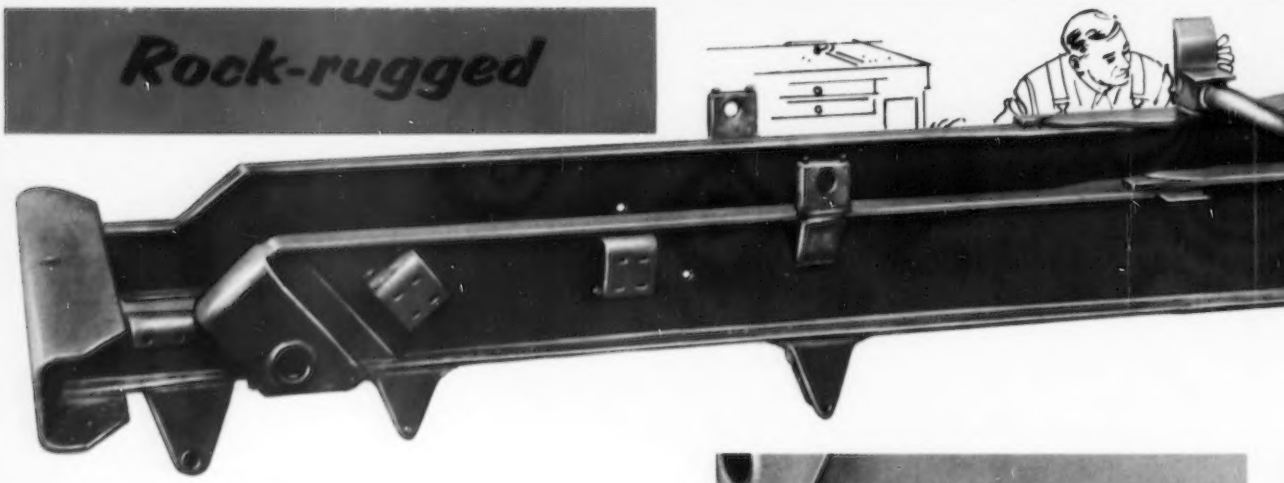




International® Pay

Rock-rugged



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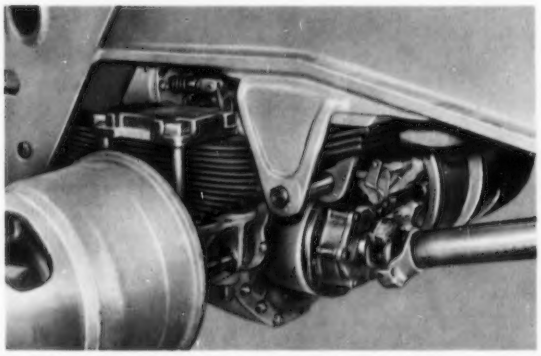

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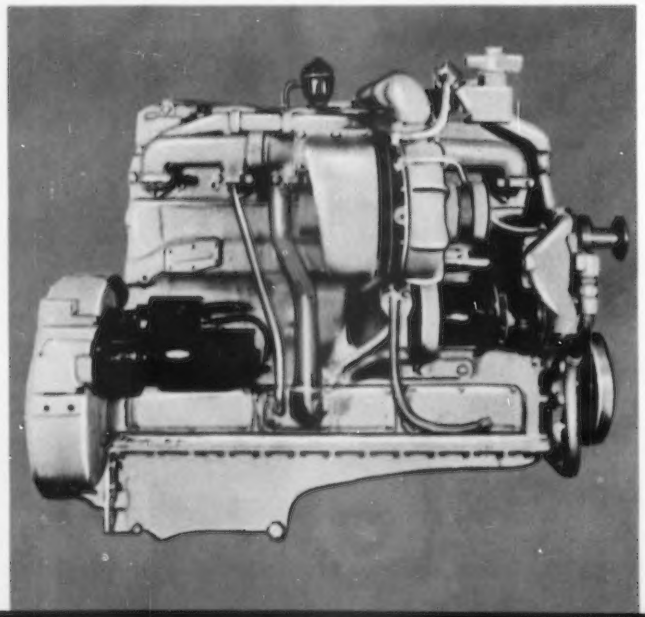
Pay-off powered



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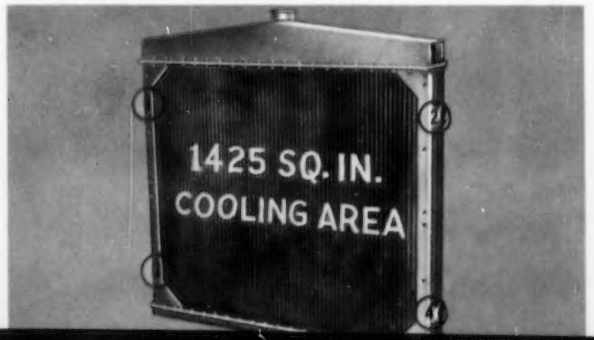
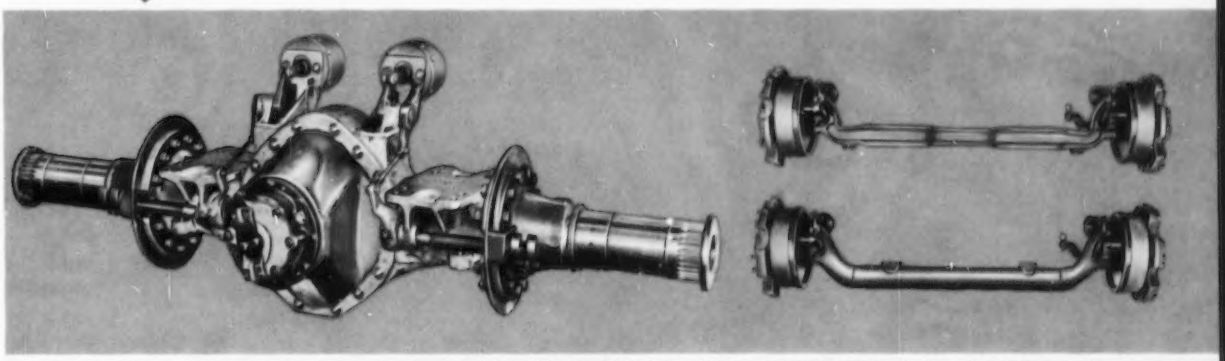
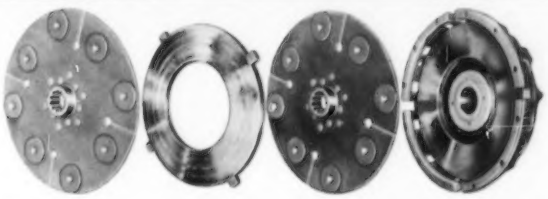


Designed for

yhaulers

Sturdy Axles. Durable axles help Payhaulers carry 36,000 to 48,000 lbs. smoothly, comfortably at speeds up to 38 mph. Note the massive differential housing with in-built spring mounting pads. Heavy-duty, rear axle housings bolt to the differential to provide top load carrying capacity. Front axles are equally sturdy—of forged or tubular design.





Cerametallic Clutch. In gear-drive models, cerametallic clutch facings virtually eliminate over-heating. This clutch, made of heat-defying material, needs fewer adjustments, gives longer life, smoother action than any other clutch in the off-highway truck field.

Torque Converter. The 24-ton Model 95 Payhauler is available with a 4-speed Torque Converter transmission for smooth speed changes from 4.8 to 38 mph. A lock-up clutch for direct drive performance and a Torqmatic brake system are standard with the versatile Torqmatic transmission. No other truck provides these features as standard equipment.

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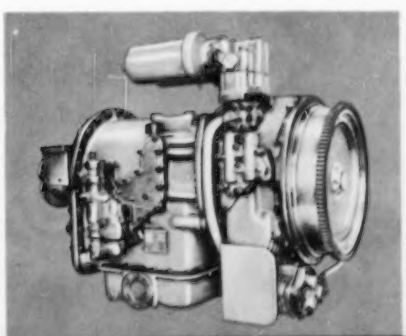
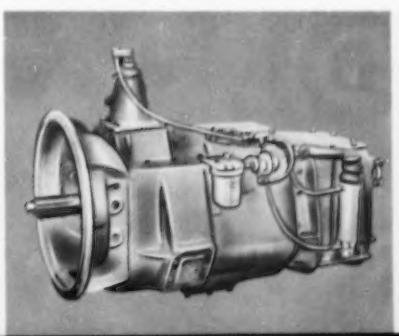
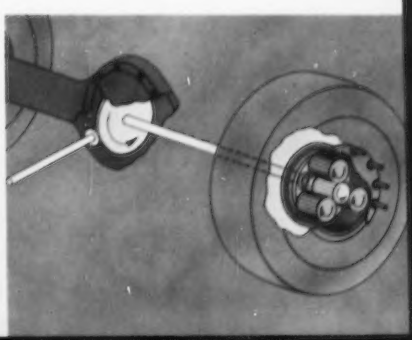
Planetary Final Drive. Both Payhaulers translate engine power into big load handling capacity through a rugged differential to planetary drive wheels. Sun gear is integral with full-floating axles for greater strength and simplified maintenance.

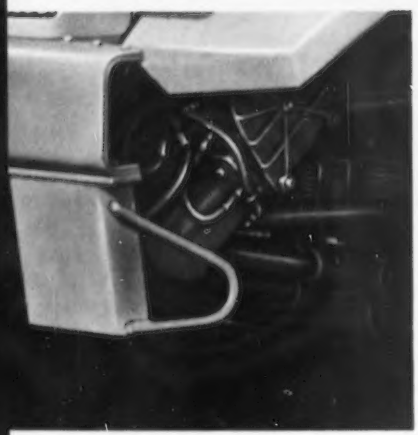




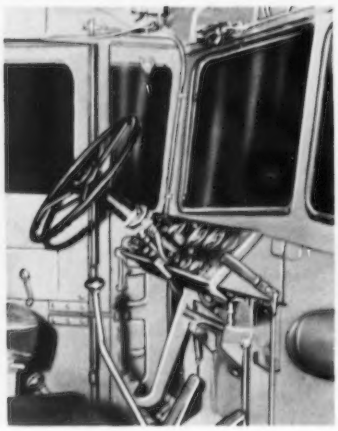


Designed for operator comfort easier operation

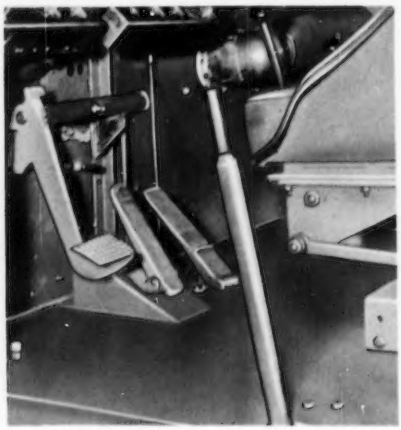
Driver looks through giant windshield, has picture window vision ahead and to both sides. When backing into close quarters, he need only open door and look around; offset cab gives unobstructed view to rear. Vents at top, bottom, and rear of cab provide a cool "office" for the operator.



Power Steering. No broken thumbs in the new International Payhaulers! Hydraulic boost gives operator power-steering control on haul roads—effortless steering when spotting under shovels.



The Driver "Takes It Easy" in the comfort-designed Payhaulers. He sits in a leather-covered, bucket-type, fully-adjustable seat. Jars and jolts are cushioned through compression spring, hydraulic shock absorber. He handles center-grouped, easy-to-reach controls. Clean floor with suspended brake pedal, handy hoist lever location make the operator's job even easier.



Accessible Service Checks. Outside mounting speeds air cleaner servicing. Inspection port in hood permits ready access to oil dip stick and filler pipe. Lightweight aluminum side sheets are easily removed for engine inspection.

Full Day's Fuel Supply. There's no need to slow down a Payhauler job for refueling. These big haulers pack 125 gallons, enough fuel for a full day's operation on most jobs. Filter-type breather caps and built-in strainers help keep fuel clean and grit-free.

4 RUGGED BODIES meet all hauling needs

Payhauler bodies are all welded, reinforced steel designed with oak fill to cushion shock loads. Inside floor and side sheets are durable Manten steel. For the Models "65" and "95", you can get a rugged quarry body—for the Model 95, two standard bodies (heated or unheated) are available to fit any job condition or material.

BRIEF SPECIFICATIONS	Model 65	Model 95
Capacity	18 tons	24 tons
Engine hp	250	335
Transmission	10-speed gear 5-speed gear	9-speed gear Torque Converter
Steering	Hydraulic	Hydraulic
Weight—Gross with Payload	76,160 lbs.	96,220 T.C.

Specifications Subject to Change Without Notice

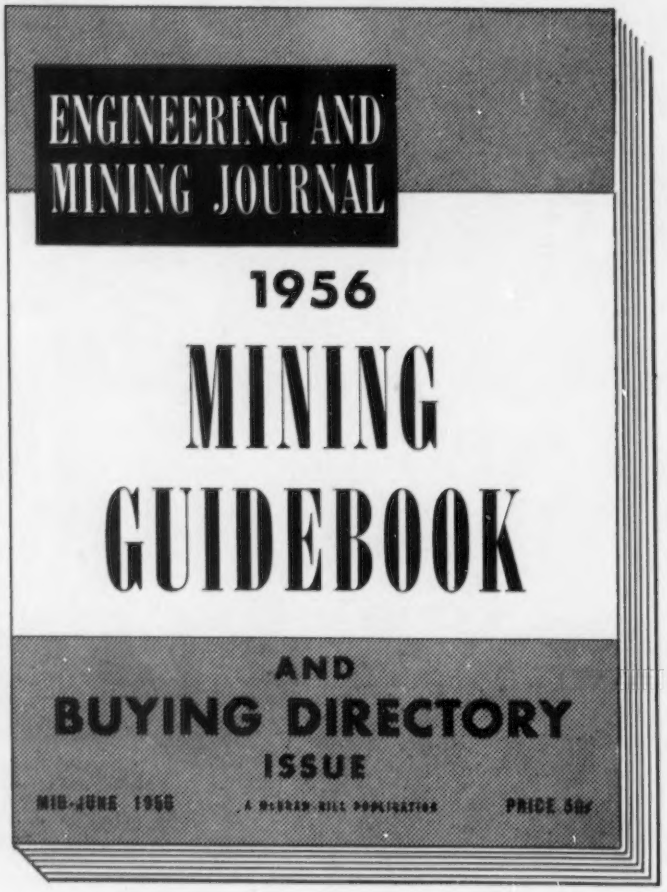
INTERNATIONAL HARVESTER

INTERNATIONAL®
Construction Equipment

INTERNATIONAL HARVESTER COMPANY, 180 N. Michigan Avenue, Chicago 1, Illinois

A COMPLETE POWER PACKAGE: Crawler, Wheel, and Pipe-Boom Tractors . . . Self-Propelled Scrapers and Bottom-Dumps . . . Crawler and Rubber-Tired Loaders . . . Off-Highway Trucks . . . Diesel and Carbureted Engines.

To the people who made this Mining Guidebook possible . . . .



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To the mining schools and technical consultants;

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HOLLOW DRILL STEEL—Crucible drill steel is available for any drilling job—in both carbon and alloy grades—and in a full range of sizes and shapes.

CARBON:
Crusca Hollow Drill Steel is the popular straight-carbon type—standard throughout the world. It's an easy to work with, all-purpose drill steel for jobs not requiring the tougher alloy grades.

ALLOY:
CA Double Diamond Alloy Hollow Drill Steel has greater hardness, higher strength than straight-carbon grades. It has superior resistance to fatigue, wear and abrasion.

4E Alloy Drill Steel is designed for the really tough jobs. Its resistance to fatigue, and its high-strength, are unmatched.

Crucible produces all these grades to *tool steel quality standards.* That means fewer broken rods—less valuable bit loss—*lower cost per foot of hole drilled.*

for the mining industry...

special steels *by* CRUCIBLE

ALLOY STEELS
Bars, billets, rods, plate, sheet, strip, wire, and special shapes in all standard AISI grades and many special analyses for . . .

car axles
chutes and conveyors
shaker screens for rock and ore crushers
coal cutting and loading machinery
drill bit bodies
bits and chisels

CASTINGS
Sand castings for pump parts
Investment castings for valves and valve seats

ELECTRODES
Welding electrodes and hard facing rods for . . .

hard facing screens, crushing and handling equipment, shovel teeth, etc.
general repairs to equipment

MAGNETS
Alnico permanent magnets for magnetos and impulse generators for blasting, miner's lamp safety locks

SPRINGS
Heavy hot wound shot-peened coil springs for crushers, locomotives and cars, vibrating screens and conveying equipment

STAINLESS STEELS
Heat and corrosion resistant stainless in all grades, types, and mill forms for . . .

vats and receptacles handling corrosive flotation materials,
pump rods
plates and angles for mancars
sifting screens

TOOL STEELS
all grades, sizes, and types for general tooling, and equipment maintenance.

Next time you need hollow drill rods—or *any* type of special purpose steel—the man to call is your local Crucible representative. He can insure immediate deliveries from warehouse stock, or prompt mill shipments. *Crucible Steel Company of America, The Oliver Building, Mellon Square, Pittsburgh 22, Pa.*

CRUCIBLE first name in special purpose steels

Crucible Steel Company of America

HARBISON-WALKER

A Complete Refractories Service for the Metal Industries

HARBISON-WALKER PRODUCTS

Super-Duty Fireclay Brick
Fire Clay Brick (all other classes)
Semi-Silica Fireclay Brick (Kaosil)
High-Alumina Brick (all classes)
Mullite Brick (H-W Mullite)
Corundum Brick (H-W Corundum)
Fire Clays
Special Clays
Silica Brick (Star)
Super-Duty Silica Brick (Vega)
Silica Fire Clays
Ground Ganister
Magnesite Brick (H-W Magnesite)
H-W Periklase
Magnesite-Chrome Brick (Magnex)
Metalkase Brick
Chrome Brick (H-W Chrome)
Chrome-Magnesite Brick
(Chromex—Chromex B)
Thermag Brick
Forsterite Brick
BASIC MONOLITHS
Magnamix
H-W C-Mix
Dead-Burned Magnesite Grains
Furnace Magnesite
Special Furnace Chrome
Insulating Fire Brick (all classes)
Light Weight Silica Brick (Vegalite)
Insulating Mortars
Bulk Insulation
Block Insulation
High Temperature Bonding Mortars
Plastic Fire Brick (all classes)
Castables (all classes)
Ramming Mixtures
Acid-Proof Brick (Duro, W-Acid)
Molding Media (Refractory)

BASIC REFRACTORIES

The superior performance of Harbison-Walker basic refractories is the result of a thorough knowledge of the requirements, extensive and continuous original research conducted by the Harbison-Walker Research Department, and highest quality raw materials processed in modern plants under close laboratory control.

CHROMEX B—an extremely hard fired chrome-magnesite refractory having unusual constancy of volume and strength at high temperatures.

METALKASE—the pioneer metal-encased basic brick, possessing an unusual combination of desirable properties.

CHROMEX—a chemically bonded chrome-magnesite brick having excellent spalling resistance.

MAGNEX—a chemically bonded magnesite-chrome brick—highly basic and of low spalling tendency.

H-W MAGNESITE—the standard burned magnesite refractory in various metallurgical industries for more than half a century.

THERMAG—a hard burned magnesite-chrome refractory possessing enhanced physical properties.

H-W CHROME—a hard burned chrome brick especially adapted for various specific uses.

FORSTERITE—the only commercially produced magnesium-silicate brick—suited for certain particular applications.

H-W PERIKLASE—an exceptionally high magnesia brick of unusual high-temperature stability.

OTHER BASIC REFRACTORIES

H-W Magnamix . . . H-W C-Mix . . . H-W Washington Dead Burned Magnesite Grains . . . H-W Washington Furnace Magnesite . . . H-W Special Furnace Chrome . . . Dry and Plastic Thermolith Batch . . . Thermolith and Other Cements . . . and Ramming Mixtures.

The outstanding records made by Harbison-Walker refractories are due to the most modern and efficient manufacturing facilities, the full complement of types and classes, and the high quality of the products.

Harbison-Walker's technical staff stands ready to assist in the selection and application of refractories that will serve dependably and economically.

REFRACTORIES

For DEPENDABLE PERFORMANCE In Every Metallurgical Operation

SOME H-W LEADING REFRACTORIES FOR COPPER FURNACES

CHROMEX B—The desirable properties which account for the excellent service secured from this extra hard fired chrome-magnesite refractory are:—high density and impermeability—relatively low thermal expansion and good resistance to thermal shock—unusual stability and strength at high temperatures. Among the important applications for this brand in copper furnaces are its use in converter linings, complete walls of refining furnaces and vulnerable positions in roofs.

H-W MAGNESITE—For the most strongly basic linings, this refractory, consisting predominantly of periclase (stabilized crystalline magnesia), fulfills the most severe requirements. It is fired at an extremely high temperature and is dense, strong and volume-stable at temperatures far above the highest employed in copper converters. The unusually high magnesia content of this refractory, together with outstanding physical properties account for the wide preference this refractory continues to gain for use in various metallurgical furnaces.

METALKASE—Among basic refractories, Harbison-Walker METALKASE brick possess the property of maximum resistance to severe spalling conditions. METALKASE brick are furnished in various sizes and shapes. It is widely used with splendid service in suspended roofs of various furnaces.

STAR AND VEGA SILICA BRICK—These two superior silica brick now are made at seven widely separated Harbison-Walker Plants. Shipments from these advantageous locations provide important savings in transportation time and cost.

STAR brand is regarded as standard for refining furnace bottoms and roofs at many plants. It is used in reverberatory Matte smelting furnace roofs and in a number of electric smelting furnaces of different designs.

VEGA is the original super-duty high temperature silica brick from which greatest benefit is derived in vulnerable positions where extremely severe operating conditions prevail.

ALUMINUM FURNACE REFRACTORIES

Refractories which are best suited for use in aluminum melting and holding furnaces possess properties which meet various specific requirements. In some furnaces, the refractories in the bottoms are subjected to severe impact and abrasion. In the production of various alloys in accordance with certain rigid specifications, the refractories used must be such that any contamination, such as silicon pick-up, is avoided. High resistance to wetting and penetration by molten metal is paramount. In the operation of many aluminum melting furnaces, the refractories are required to withstand severe spalling conditions.

KORUNDAL—The unusual combination of desirable physical properties of this 90% alumina refractory, makes it particularly adapted for use in bottoms and lower side walls. KORUNDAL is very strong and resistant to mechanical abuse, penetration by molten aluminum and thermal spalling.

H-W CORUNDUM—is a 99%+ alumina refractory which is used in the linings of certain furnaces for melting pure aluminum, free from any contamination.

ALAMO—Along with other Harbison-Walker super-duty fireclay brick brands, ALAMO is favored for upper walls and roofs.

Harbison-Walker products for aluminum furnaces comprise several other high-alumina refractories, high-duty fireclay brick brands possessing the particular properties needed for best performance in this service. Also included are all the various classes of castables and other monolithic materials as well as high temperature bonding mortars especially suited for this requirement.

OTHER NON-FERROUS METAL FURNACES

The service conditions in furnaces employed in the numerous non-ferrous metallurgical processes vary widely, and the refractories must meet highly specialized requirements. The selection of the proper refractory frequently governs the degree of success of the processes employed in the reduction, refining and melting of these metals. Harbison-Walker products comprise all the different types and classes of refractories needed for all the metallurgical processes, such as for the reduction and refining of nickel, lead, zinc, magnesium and other metals.

HARBISON-WALKER REFRACTORIES COMPANY
AND SUBSIDIARIES
WORLD'S LARGEST PRODUCER OF REFRACTORIES
General Offices... Pittsburgh 22, Pennsylvania

Serving Both Hemispheres of the Mining World

For forty years Cyanamid has provided metallurgical chemicals and processes for the mining industry the world over. Today—Cyanamid offers a variety of flotation reagents, AERO® Brand Cyanide, sodium cyanide and the powerful synthetic flocculants, the AEROFLOC® Reagents, as well as other metallurgical chemicals. Continuing research work for developing new products assures tomorrow's mining world of more profitable and more efficient operations.

CYANAMID

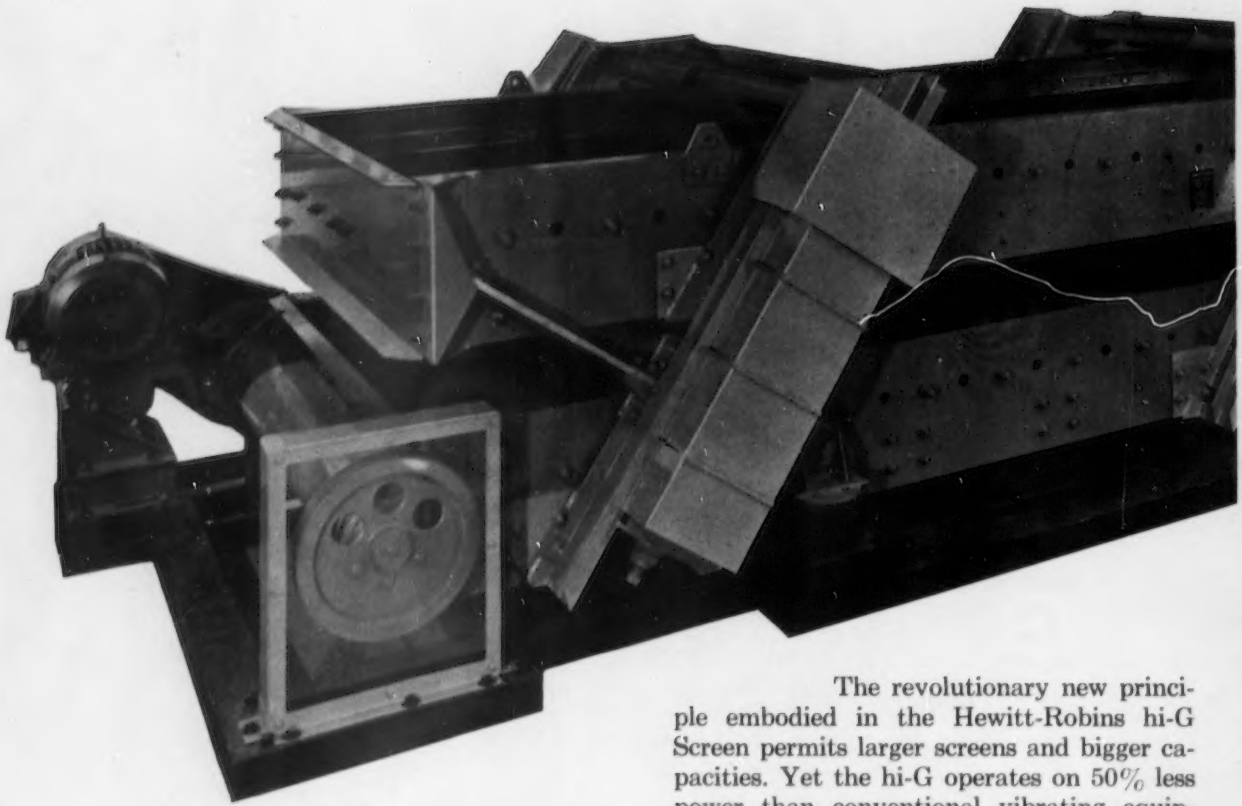
AMERICAN CYANAMID COMPANY

MINERAL DRESSING DEPARTMENT

30 ROCKEFELLER PLAZA, NEW YORK 20, NEW YORK

HEWITT-ROBINS *hi* G SCREENS

50 Per cent Savings



The revolutionary new principle embodied in the Hewitt-Robins hi-G Screen permits larger screens and bigger capacities. Yet the hi-G operates on 50% less power than conventional vibrating equipment! Even screens as large as 6' wide by 28' long require no more than a 20-HP drive.

Featuring an unusually sharp screening action, and a choice of stroke and speed combinations, the hi-G can be made in larger sizes than any other vibrating screen on the market.

New "Modified Resonance" Principle

Utilizing the principle of "modified reso-

INDUSTRIAL DIVISIONS PRODUCTS

VIBRATING SCREENS • VIBRATING CONVEYORS

CONVEYOR BELTING • CONVEYOR MACHINERY

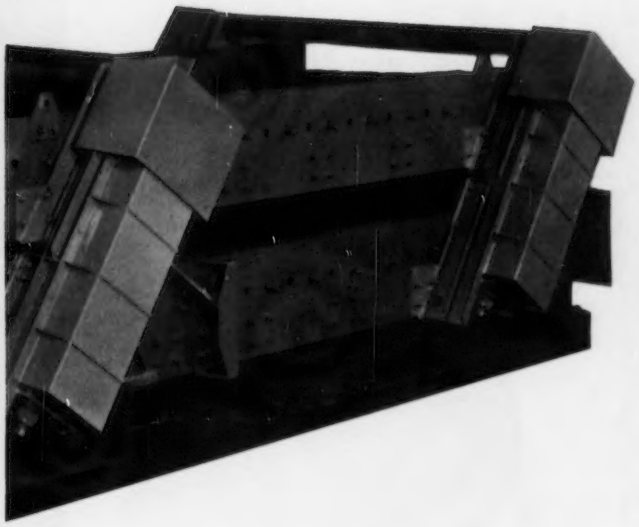
INDUSTRIAL HOSE • DESIGN, MANUFACTURE, ENGINEERING AND ERECTION OF COMPLETE BULK MATERIALS HANDLING SYSTEMS

"GLIDE RIDE" THE NEW MOVING SIDEWALK

HEWITT

STAMFORD,

SAVE POWER *Possible*



nance," the new Hewitt-Robins hi-G Screen develops a controlled, extremely sharp vibrating action. This resonance is induced by a relatively small mechanical exciter producing powerful vibrations with added "kick" to separate materials according to size.

If you need larger screens—screens that operate on or near the horizontal and still screen at large openings—*screens with readily accessible lower decks for easy observation, spraypipe installation and quick cloth changes* . . . the hi-G Screen is your answer. For information about hi-G Screens and other Hewitt-Robins vibrating equipment, contact our nearest sales office or write to our offices in Stamford, Connecticut.

-ROBINS

CONNECTICUT

HEWITT-ROBINS VIBRATING EQUIPMENT FOR THE METAL MINING INDUSTRY

GYREX SCREENS. General-purpose, positive-stroke, 4-bearing screen with amazing versatility of application and an unsurpassed record for stamina in service.

STYLES M AND MS VIBREX SCREENS. Full-floating, unbalanced, pulley-type, 2-bearing screen. Offers sharp sizing of a wide variety of materials at low cost.

STYLE J VIBREX SCREENS. General-purpose screen applicable to a wide variety of screening operations. Wide range of sizes for suspended mounting.

STYLE HS HIGH-SPEED VIBREX. For fine screening applications (up to 100-mesh in some cases). Highly effective circle-throw screening action.

ELIPTEX SCREENS. Exclusive 3-way elliptical motion for sharpest sizing and most effective dewatering. Horizontal-operating flat screens.

CAR SHAKEOUTS. Both Heavy-Duty and General-Service units for unloading all sorts of materials from hopper cars faster, more efficiently and more economically.

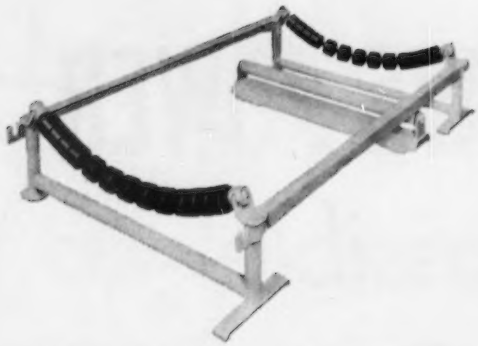
VIBRATING FEEDERS. Fully mechanical vibrating feeder. Easy to install, operate and maintain. Extremely high capacities at very low power consumption.

VIBRATING CONVEYORS. To convey practically any substance in almost any form or condition. Available in several widths up to 150 feet in length with only one vibrator.

SCREEN CLOTH. Wire cloth in a variety of sizes, weaves and materials for virtually every sizing, separating or screening operation.

FOR SERVICE AND INFORMATION ON BELTING AND HOSE CALL YOUR LOCAL HEWITT-ROBINS INDUSTRIAL SUPPLY DISTRIBUTOR LISTED IN THE "YELLOW PAGES"

New EQUIPMENT FOR ECONOMICAL Mining



LIMBEROLLER Unique 2-bearing belt conveyor idler shapes to load, resists dust, abrasion, corrosion and material buildup. Gives up to 12 times the life of conventional steel idlers, yet weighs 2/3 less. Resilient neoprene or rubber discs molded to flexible steel cable give "no-bump" support. Light and easy to handle, stack, change out on line. Available in portable or bolt-on stands for belt widths of 18", 24", 30", 36" and 42".

AXIVANE FAN Delivers the fresh air you need with the least expenditure of power. Joy offers a big selection of fans especially designed to solve the problems of mine ventilation. Axivane Fans engineered by Joy have operating efficiencies of 80% and higher, offering CFM ratings over 1 million. Made to mining specifications. Joy Axivane Fans give long range economy and reliable continuous service.

THE JUNIOR CHALLENGER A push-button control drill—the first completely power-operated wagon drill ever produced. It drills anywhere, in any position, in any formation. All movement of feed, drill and carriage is hydraulic or air-powered. Mounting a new 4½" drifter, the Junior Challenger drills 3½" holes to 40 feet depth and drills horizontal holes at heights up to 7½ feet.

Consult a Joy Engineer

JOY MANUFACTURING COMPANY
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JOY

WORLD'S LARGEST MANUFACTURER
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Other Joy Products: BLAST HOLE DRILLS • CORE DRILLS • AIR COMPRESSORS • WAGON DRILLS • ROCK BITS • HAND-HELD DRILLS • BREAKERS • TAIL ROPE SHEAVES • CONTINUOUS MINERS • FANS & BLOWERS • HOISTS & SLUSHERS • SCRAPERS • CONTRACT CORE DRILLING • DIAMOND BITS • SHUTTLE CARS • LOADERS • CONVEYORS • ELECTRICAL CONNECTORS • HYDRAULIC HOSE COUPLINGS • SHAFT MUCKER • PORTABLE AIR-DRIVEN LIGHTS • DRILL JUMBOS • PORTABLE LIGHTING LINES

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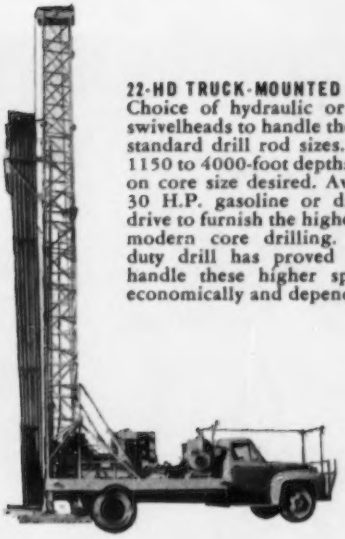
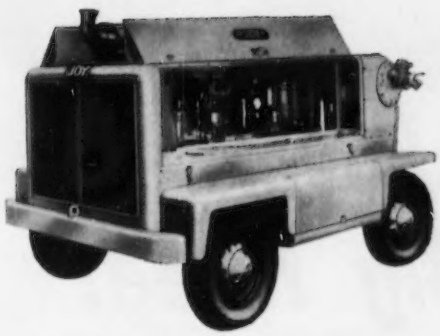


22-HD TRUCK-MOUNTED CORE DRILL Choice of hydraulic or screw feed swivelheads to handle the new or old standard drill rod sizes. Drills from 1150 to 4000-foot depths, depending on core size desired. Available with 30 H.P. gasoline or diesel engine drive to furnish the higher speeds for modern core drilling. This heavy duty drill has proved that it will handle these higher speeds safely, economically and dependably.

TUNGSTEN CARBIDE ROCK BIT With tungsten carbide inserts. The only bit that is case hardened to make it the hardest in use today consistent with maximum shock resistance and high fatigue life. Case hardening makes the Joy Tungsten Carbide Rock Bit best for any rock formation. Cross type available in sizes from 1½" to 3" and X-type in sizes 3½", 4" and 4½".



AIRVANE MODEL RP-600 ROTARY COMPRESSOR Offers design features found in no other similar portable and which provide remarkable economy and efficiency. Thermal By-Pass heats oil quickly, keeps oil flowing regardless of outside temperature, and provides immediate lubrication on starting. Filter-Separator removes oil from air and returns it to circulation system, reduces oil consumption.

JAL-47 AIR LEG AND LM-47 DRILL Combines a lightweight feed leg with a harder hitting, stronger rotating drill. The heat-treated, aluminum-alloy air leg is attached to the drill at a pivot point nearest the horizontal center to provide good balance for ease of handling and to keep the drill and steel in alignment. Directional feed control valve, built into the drill backhead, permits easy one-hand control. Comes in 36", 42" and 48" feed lengths.

HPD HIGH PRESSURE HYDRAULIC ROTARY DRILL Designed for underground mining in medium hard rock. Will drill 1⅜" to 1⅝" diameter holes to twelve feet at speeds of three to five feet a minute. In iron, lead and copper ores and in limestone it has penetrated from two to five times the rate of percussion drills. Two models are available: the HPD-3, mounted on a self-propelled, rubber tired, 4-wheel chassis; and the HPD-4 for mounting on customer's rig.

60-BH SUPER HEAVYWEIGHT CHAMPION Capable of drilling 9" to 12" holes in even the hardest formations. Is the largest in the outstanding line of Joy "rotary air-blast" drills. The 60-BH excels in all three of the features which determine bit penetration: more powerful bit rotation coupled with infinite variation and accurate control of bit speeds; Joy hydraulic feed, most efficient method of applying bit pressure; use of Joy heavy-duty, water-cooled air compressor for cuttings removal. Smaller models of the Champion available: 56-BH Middleweight and 58-BH Heavyweight.

Which electric shovel leads the Big Three?

Magnetorque* and Electronic Controls put P&H WAY AHEAD!

How can P&H performance be so far ahead of all other electric shovels?

One reason is Magnetorque, the electro-magnetic transmission that gives smooth, stepless operation. Just look what you get. Simplest hoist control, by far. Simplest hoist machinery, by far. Instant response to control and load changes. Automatic cushioning of shock loads. Greater bail pull *in the bank!* Greater efficiency. Cuts maintenance and operating costs. Plus many other advantages. Exclusive with P&H.

Another reason. P&H Electronic Controls. They give you instant response to signal. Stepless control. 12% fastest cycle. 16% savings in operating time. Less operator fatigue. Harnischfeger Corporation, Milwaukee 46, Wisconsin.

*Trade-mark of Harnischfeger Corp. for electromagnetic type coupling.

For Modern Engineering, Look to

HARNISCHFEGER

P&H ELECTRIC SHOVEL DIVISION

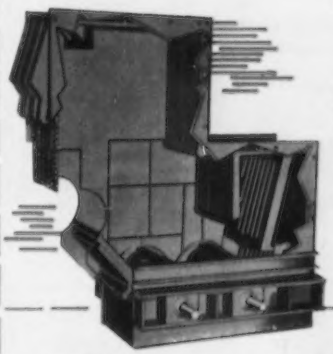
the P&H *Line*

KENNEDY Machinery & Equipment

for the MINING INDUSTRY

KVS Machinery and Equipment is in use throughout the world and enjoys an outstanding reputation for dependability, low operating and maintenance cost.

Machinery illustrated covers only a small portion of our line. We manufacture everything from a crusher to a complete mining plant. Consultation with KVS engineers can be arranged anywhere in the world.

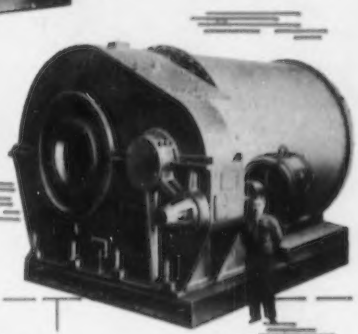


CUBER SENIOR, (Model 3648)

Multi-stage, regulated flow impact breaker for primary and secondary crushing. Dual rotor, triple action. Breaks non-abrasive stone and similar materials. Produces wide range of aggregate sizes with full gradation control. Available in portable or stationary models.

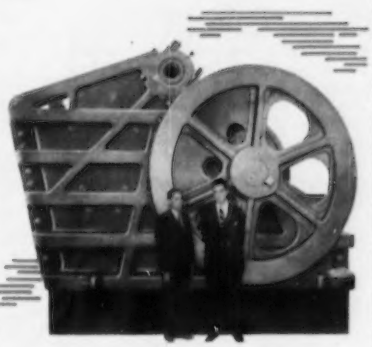
GYRATORY CRUSHERS

Gearless, primary and secondary types in a wide range of capacities. Features include Synchronous Motor, built integral into pulley; power used only for crushing.



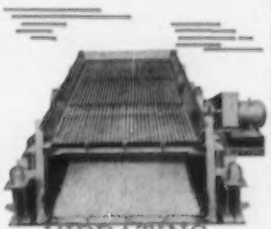
BALL AND RODMILLS

Furnished in any length and diameter. Balls may be added while mill is in operation. Available in models for either wet or dry grinding.



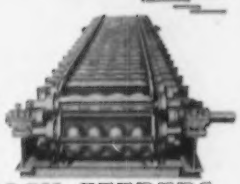
SWING JAW CRUSHERS

Complete range of heavy duty sizes and capacities from 6,000 to 600,000 lbs. Jaw plates reversible, end to end, side to side for long wear. Frames of larger sizes built in four sections for easier installation. Swing Jaw Shaft cast integral with Swing Jaw.



VIBRATING SCREENS

Single, double or triple deck models with interchangeable mesh. Screens have four-way motion; all models available in wide range of sizes.



ROCK FEEDERS

Heavy duty for continuous crusher feeding from steam shovel, truck or railroad cars. Operates at variable speed, equipped with overlapping pans. Widths, from 24 in. to 84 in., in lengths to suit requirements.

Send for bulletin describing KVS Machinery and Equipment

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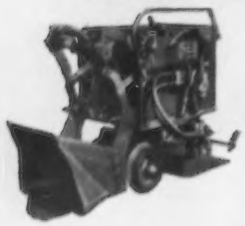
EIMCO ROCKERSHOVELS



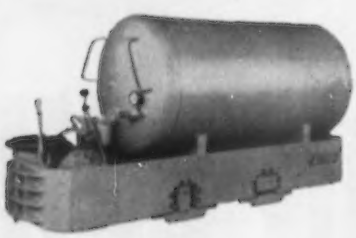
MODEL 12B
Air or electric powered. Loading speed 20 to 35 cu. ft. per min. Dimensions: Width 28". Caging length 44". Length (bucket down) 73"*. Head room 78½"*. Clean-up range 83"†. Weight 4500 lbs. Track gauges 15" to 36".
*Standard †Without side plow

MODEL 21
Air or electric powered. Loading speed 35 to 50 cu. ft. per min. Dimensions: Width 33½". Caging length 55". Length (bucket down) 87"*. Headroom 88"*. Clean-up range 98"†. Weight 7200 lbs. Track gauges 18" to 48".
*Standard †Without side plow

MODEL 40H
Air or electric powered. Loading speed 60 to 100 cu. ft. per min. Dimensions: Length (bucket down) 20'8½". Headroom 8'0". Belt width 28". Clean-up range 12'. Weight 16,850 lbs. Track gauge 28" to Std. Railroad. Wide gauge can be built to tram on 24" gauge.

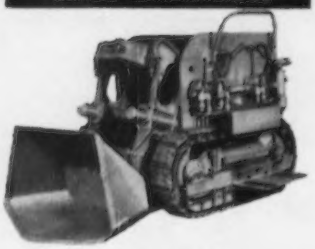
MODEL 15
Electric or gasoline powered. Rubber tired. Hopper or conveyor. Loading speed 20 to 40 yards per hour. Dimensions: Width 5'9", Length 10'2". Weight with hopper 8000 lbs., with conveyor 9310 lbs.

EIMCO AIR LOCOMOTIVES

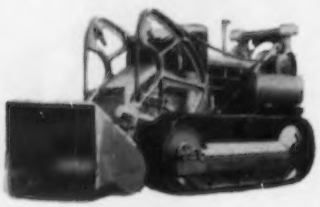


Two speed constant mesh transmission. Inspected and serialized to meet A.S.M.E. unfired pressure vessel code. Two sizes. Dimensions: Receiver size 32"x84"[1] or 40"x84"[2], Width 32"[1] or 40"[2], Height above rail 48½[1-2], Wheelbase 30"[1-2], Working pressure P.S.I. 110[1-2], Weight 2790 lbs.[1] or 3260 lbs.[2]

EIMCO EXCAVATORS

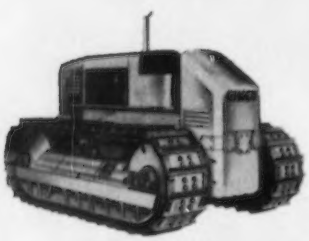


630 EXCAVATOR
Designed for trackless operations underground. Air or electric powered. Independent control of each track. Available with an assortment of attachments. Loading speed 600 to 800 tons per shift. Headroom 6'8". Width 5'8½". Length (bucket down) 9'4".



105 TRACTOR-LOADER
105 Tractor with loader attachment. Designed for heavy-duty loading and excavating work of all types. Loading speed 6 to 8 cu yds. per min. Headroom (std.) 13'6". Length (bucket down) (std.) 16'6". Track gauge 74". Weight 37,000 lbs.

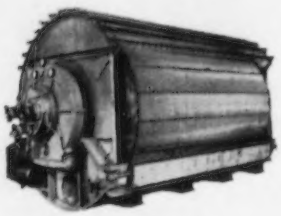
EIMCO TRACTOR



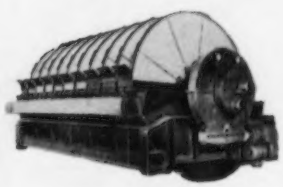
105 TRACTOR
Diesel powered prime mover — available with bulldozer, loader and other attachments. Front and rear power take off. Independent control of each track. Exclusive Unidrive transmission which eliminates all manually operated clutches. Up front operator position for full visibility. Dimensions: Height 7'3". Length (base) 12'6". Track gauge 74". Weight 26,000 lbs. Drawbar-pull (calculated) max. with grousers at zero track slippage 40,000 lbs.

EIMCO FILTERS

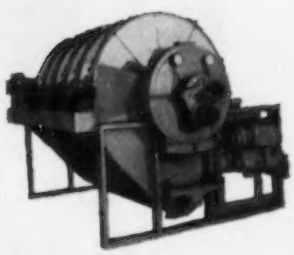
DRUM FILTERS
Features individual design. Provides deep drainage sections, greater piping area and large streamlined valves. Construction materials vary with material filtered and local operating conditions. Face length 2' to 18'. Drum diam. 4' to 12'. Other sizes made to specifications.



DISC FILTERS
Designed according to slurry characteristics. Construction materials for filter and disc sectors vary with material filtered and local operating conditions. Number of discs 1 to 12. Disc diam. 4'0" to 12'6". Other sizes made to specifications.

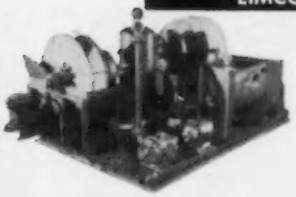


AGIDISC FILTERS
Designed for a comparatively wide range of particles in suspension, where the density of feed is lower and settling is rapid. Construction materials for filter and disc sectors vary with materials filtered and local operating conditions. Number of discs 1 to 12. Disc diam. 4'0" to 12'6". Other sizes made to specifications.

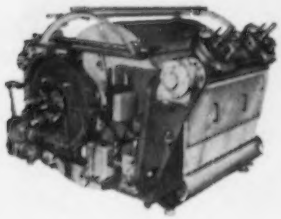


EIMCO FILTERS

PLATFORM FILTER STATIONS
Constructed on a structural steel subbase and available with drum, disc, pan, pressure, or plate and frame units for pilot plant or small filter stations. Auxillary equipment: receivers, vacuum and filtrate pumps, blower, motors, piping and central control panel.



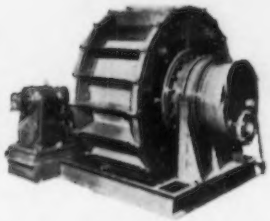
LAB FILTERS
Drum or disc units specially constructed on a flat platform or in a cabinet, which include all necessary operating equipment for a pilot plant or laboratory filter station. Construction materials to specifications.



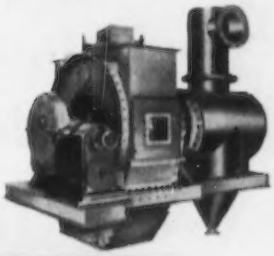
PRECOAT FILTERS
Available for open, vapor and pressure tight requirements. Can be converted from open to vapor or pressure tight units in the field without changing existing units. Materials to specifications. Face length 2'0" to 16'0". Drum diam. 4'0" to 8'0".

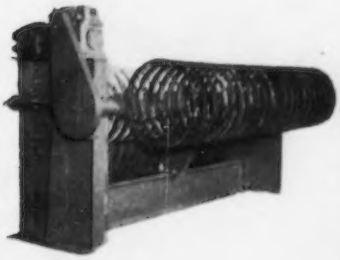
PRESSURE FILTERS
Available with drum or disc unit inside a pressure vessel. Designed for pressure up to 150 P.S.I. and to A.S.M.E. code. Construction materials to specification. Maximum diam. 8'0" for std. drum, disc, Agidisc and precoats. Dryers, max. 6'0". Cake discharge is by sealed screw conveyors or pressure tank.

DEWATERERS
Designed and especially adapted for high capacity dewatering of the slurrys with fast settling solids. Construction materials vary with material to be dewatered and installation specifications. Face length 3'0" to 6'0". Drum diam. 1'0" to 5'0". Other sizes to specifications.



DRYERS
Designed and particularly suited for granular or crystalline materials which are fast settling in solution. Streamlined head assembly to direct heated airflow through cake and receiver. Face length 3'0" to 6'0". Drum diam. 1'0" to 5'0".





EIMCO-BURWELL FILTERS
Designed with two sets of circular frames, each pair mounted at 180° of each other on a common shaft. One frame is always ready for operating. While the other is extended in cleaning position. Number of frames 2 to 30. Frame thickness sizes 1", 1½", 2", 2½", and 3".

FILTER MEDIA

The synthetic and natural fabrics available through Eimco are the most modern materials developed for filtration equipment in the Chemical and Processing Industries. Eimco's skilled filtration engineers will help you find the best filter medium to meet your specific filtration problems.

OTHER EIMCO EQUIPMENT

AIR HOSE
Eimco Air Hose — extremely flexible wire braid. Neoprene tube that will not collapse. Natural rubber cover treated for resistance to abrasion and impact. Will not sun check. Available in sizes of ½" to 4" with or without connections. Write for bulletin H4003.

AIR MOTORS
Eimco Air Motors are five cylinder radial type motors for reversible or non-reversible service. Heavy-duty construction with special attention to streamlined air passages make the Eimco the most efficient air motor on the market. Write for bulletin L1026.

LINERS
Utaloy Ball, Rod and Tube mill liners. An alloy cast steel, representing the ultimate in controlled microstructure. For longer mill runs and reduced grinding costs. Actual job data shows that "Utaloy" liners will grind more tons per set. Write for Utaloy "5Q," bulletin C3003.

GEARED AIR MOTORS
Eimco Air Motors are five cylinder radial type. Either flange or pedestal mounted or in a variety of gear reductions with a full range of speed reduction units. Precision made. Reversible. High starting torque. Dynamic and static balancing for highest efficiencies and smooth operation. Write for bulletin AE6001.

BALL MILLS
Eimco cylindrical type ball and rod mills with either central overflow or grate discharge are available in a wide variety of sizes. Any Eimco mill can be converted from central overflow to grate discharge or vice-versa. Extra heavy-duty construction. Write for information and specifications.

FOLDING SCRAPERS
Eimco Folding Scrapers are heavy-duty high capacity scrapers. Folding feature makes scraper require less power on return pull and dig in for full load on every trip. Cast of abrasion and impact resisting alloy steel. Write for bulletin C3004 for information and specifications.

THE EIMCO CORPORATION

Salt Lake City, Utah—U.S.A. • Export Offices: Eimco Bldg., 52 South St., New York City

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Gardner-Denver . . . Serving the World's Basic Industries

Lightweight Air Feed Leg Drills

Automatic Water-Control Stopers

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Drill Steel Shapers and Sharpeners

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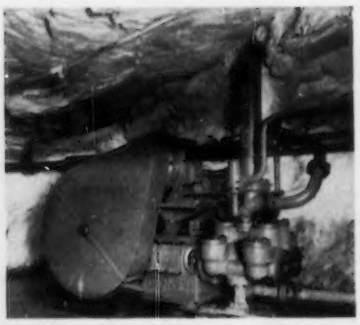
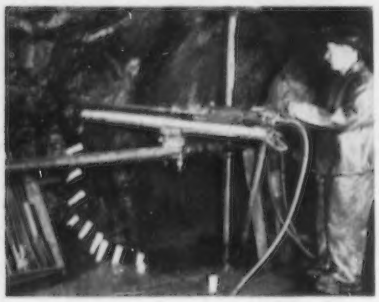
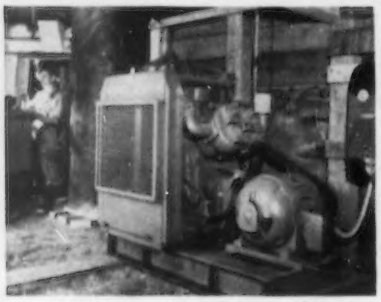


De-Watering, Grout and Sump Pumps



Deep Hole Drilling Equipment



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Fast, Safe Mine Car Loaders

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THE QUALITY LEADER IN COMPRESSORS, PUMPS, ROCK DRILLS AND AIR TOOLS FOR CONSTRUCTION, MINING, PETROLEUM AND GENERAL INDUSTRY

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SOUTH DAKOTA MINE REPORTS:

"Du Pont MS Delay Caps give greatly improved fragmentation in stopes

1. **BLASTER PRIMING DYNAMITE**—Du Pont "Gelex"® #2 (1⅛ x 8)— with Du Pont MS* Delay Electric Blasting Caps at the Homestake Mining Co., Lead, South Dakota.

2. **MINER CONNECTING UP ROUND.** Use of MS Delays improves fragmentation, prevents cutoffs and eliminates possibility of dynamite in the muck.

3. **ROUND IS READY** for firing with Du Pont CD Blasting Machine. These machines eliminate hard-to-maintain permanent firing lines.

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You'll benefit by learning more about MS Delay Electric Blasting Caps and the entire line of Du Pont Products for blasting. Ask your Du Pont Explosives representative or write E. I. du Pont de Nemours & Co. (Inc.), Wilmington 98, Del.

*"MS" (Millisecond) Delays with copper or iron wires are available in following delay periods: MS-25, -50, -75, -100, -125, -150, -175, -200, -250, -300, -350, -400, -450, 500, -600, 700, -800, -900, -1000

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Blasting Supplies and Accessories

DU PONT

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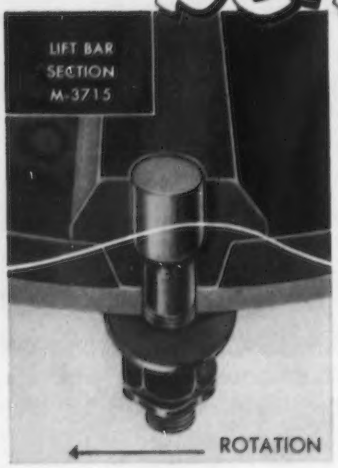
BETTER THINGS FOR BETTER LIVING . . . THROUGH CHEMISTRY

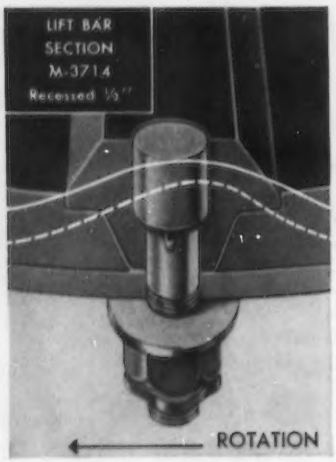
Four USS Lorain Rolled Plate Linings

better 4 ways...

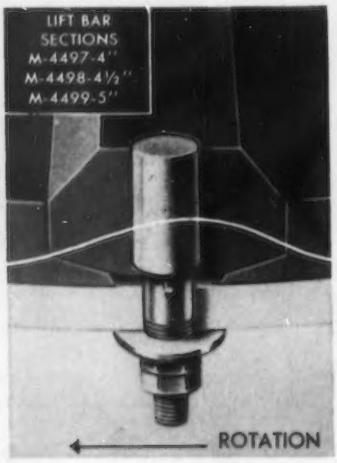


This type of low-cost lining is recommended for cement and soft grinding jobs. Plates are available in 1¼" and 1½" thicknesses. Bars are 6" wide—with 1⅝" lift. Ideal with balls up to 1¼" diameter. Line indicates maximum wear pattern.

Plates are available in 1½", 2", 2½" and 3" thicknesses. Bars are 7" wide—2½" lift. Designed for use with larger diameter balls up to 4". Line indicates maximum wear pattern.



Plates are available in 2", 2½" and 3" thicknesses. Bars are 7" wide. With the ½"-deep plate recesses, lift is 2". Because of the recessed design, bearing surface is retained permitting replacement of lift bars for extended service. Solid line indicates wear pattern with original bars. Dotted line indicates wear line of replacement bars.



Heavy duty linings and lift bars for toughest grinding assignments. Plates are available in 2", 2½" and 3" thicknesses. Bars are 8⅛" wide. Variable lifts from 1¼" to 2½" are available. Line indicates maximum wear pattern.

These four important features of USS Lorain Rolled Plate Linings mean peak grinding efficiency . . . no matter what the grinding assignment. Compare them with *any* other liners on the market.

1. These are the only linings made of *hot rolled* steel. Our bars and plates are not castings, but are special hot worked steel, given superior toughness that eliminates breakage even when worn to paper thinness.

2. Lift bars are of rolled alloy steel with extra hardness and toughness that provides lift and better grinding efficiency throughout the life of the lining. For more severe service, bars are heat treated.

3. Lift bars and lining plates are made to exact dimensions for close tolerances that permit snug fit and eliminate shell wash—no zincing required.

4. Better design, better materials – they permit the use of thinner linings, thus increasing mill capacity.

Call on us for expert technical assistance on any grinding problem.

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USS

See The United States Steel Hour. It's a full-hour TV program presented every other week by United States Steel. Consult your local newspaper for time and station.

USS LORAIN ROLLED PLATE LININGS and USS GRINDING BALLS

5-2477

UNITED STATES STEEL

ORDER OR SPECIFY SPRAGUE & HENWOOD "ORIENTED" DIAMOND BITS

LOWER COST-PER-FOOT

Sprague & Henwood, in close co-operation with the United States Bureau of Mines, initiated the practice of "Orienting" drilling diamonds in their diamond bits. It was believed that by "Orienting" drilling bortz in their hard vector direction, that the "cost-per-foot drilled" should be substantially reduced.

Sprague & Henwood's contract drilling department has used over 30,000 "Oriented" diamond bits, and has supplied customers with thousands more. Proof that Sprague & Henwood "Oriented" diamond bits reduces the "cost-per-foot drilled" is explained and outlined in detail in Bulletin #320-1.

All Sprague & Henwood diamond bits are designed to do a specific job, and with information concerning your particular problem, Engineers will suggest and supply you with the Bit, Reaming shells and all accessory equipment necessary to give you the most for your drilling dollar.

Sprague & Henwood has developed four different types of matrices to be used if formation ranging from very soft, to extremely hard or highly abrasive stratas.

When you need diamond bits . . . Call Sprague & Henwood in Scranton, the phone number to remember is DIamond 4-8507. You furnish the information on your conditions. They will supply you with the finest diamond drilling bits you can possibly buy anywhere.

IMPREGNATED CORING BIT
Especially suitable for drilling through hard, broken or extremely abrasive ground, where diamond loss from surface-set bits might be excessive. EX, AX, BX and NX sizes carried in stock. Larger sizes and special designs when required.

DOUBLE-TUBE REAMING SHELL
Available in all standard sizes for use with all types of double-tube core barrels. Special sizes and types as required. Inserts are tough tungsten-alloy matrix set with carefully selected diamonds.

"M" SERIES "ORIENTED" DIAMOND CORING BIT
For use with "M" SERIES Core Barrel, when good cores must be secured from soft or friable strata. Available in all four types of matrix and three different grades of diamonds. Also in a complete range of impregnated sizes. EX, AX, BX and NX sizes carried in stock.

"ORIENTED" DIAMOND "TAPER" TYPE NON-CORING BIT
The fastest cutting bit for drilling blast holes in very hard formations. All standard sizes.

"ORIENTED" DIAMOND "PILOT" TYPE NON-CORING BIT
Recommended for drilling blast holes in hard formations and also for use when long straight holes must be drilled in variable formations.

"ORIENTED" DIAMOND "CONCAVE" TYPE NON-CORING BIT
Especially suitable for drilling round smooth holes in relatively soft formations, when cores are not required. All standard sizes available in four different types of matrix.

"ORIENTED" DIAMOND CASING-SHOE BIT
Available in the same wide range of sizes and types as the standard casing bits and designed so that they can be left on the end of the casing in the hole while drilling is continued through them with the corresponding standard size of core barrel and bit.

"ORIENTED" DIAMOND STANDARD CASING BIT
Available in all standard sizes with a choice of four different matrices and three different grades of selected diamonds. Larger sizes and special designs furnished as required. Must be removed before continuing to drill with core barrel and bit.

"ORIENTED" DIAMOND CORING BIT
Available in four different matrices and three different grades of correctly-sized diamonds. EX, AX, BX and NX sizes carried in stock. Larger sizes and special designs furnished to meet any specifications or requirements.

SPECIFY SPRAGUE & HENWOOD FOR FAST... DEPENDABLE... RESETTING SERVICE

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MODERN . . . DEPENDABLE . . .
HIGH SPEED DRILLING MACHINES
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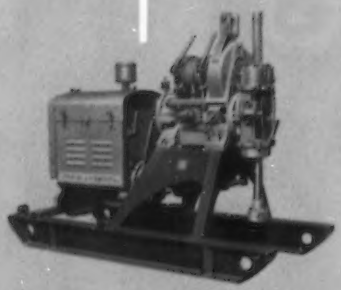
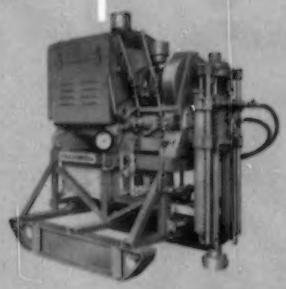
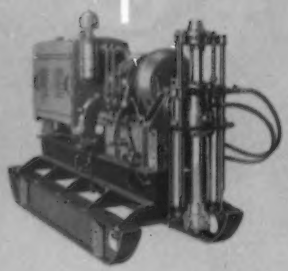
YOUR COMPLETE DIAMOND CORE DRILLING - CENTER -



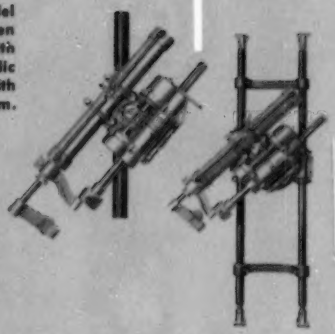
Sprague & Henwood Model 40-C Gasoline Engine Driven Core Drilling Machine, Low mount type, with screwfeed swivelhead. Bulletin # 185-1



Sprague & Henwood Model 40-C Gasoline Engine Driven Core Drilling Machine with size "A" double hydraulic swivelhead, oil operated with built-in oil circulating system.



Sprague & Henwood Model 142 Gasoline Engine Driven Core Drilling Machine, with built-in oil circulating system and hydraulic swivelhead. Bulletin # 160



Model 325 and Model 550 Air operated machines for diamond core drilling underground. Driven by four cylinder radial-type air motors, both of these modern machines have ample capacity for fast steady operation.

ACCESSORY EQUIPMENT

A new and complete catalog No. 400 listing all accessory equipment is available. Write for your free copy today. It will be mailed promptly.

CONTRACT DIAMOND DRILLING...ANYWHERE

For over 70 years Sprague & Henwood has been the leader in the contract diamond drilling field. In that time, crews have completed thousands of contracts successfully, all over the world, in every conceivable condition.

For the best in exploratory core drilling (surface or underground), blast hole drilling, directional drilling, foundation test drilling, grout hole drilling, and pressure grouting—be sure to call Sprague & Henwood. Estimates and suggestions given without charge.

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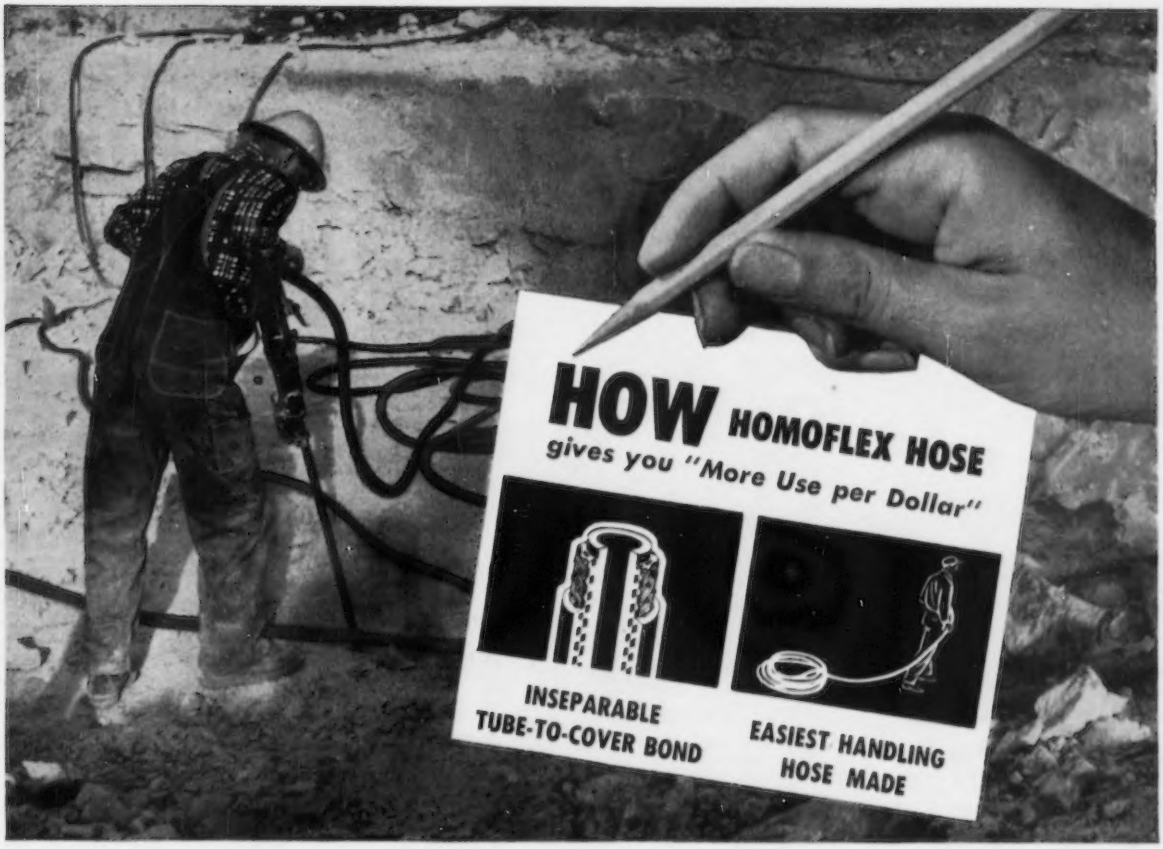

This Easiest Handling Hose Gets More Work Done–Cuts Labor Costs

Bulk and stiffness have been engineered *out* of this modern hose. The unique construction of Homoflex Hose makes it light, flexible as a rope, yet strong. Made with no pre-set twist, it coils and uncoils *without* kinking. Exclusive R/M engineering creates a homogeneous cover, strength member and tube that are virtually inseparable . . . . This hose is easier to handle, yet strong and safe for the toughest jobs!

Homoflex Hose is easier to couple, too, because it has uniform inside and outside diameters. All these features mean that Homoflex Hose lasts longer, gets more work done, handling air, water, other fluids and gases. Ask the R/M representative to show you how Homoflex Hose and other types of R/M hose for general and special purpose use do a better job, longer . . . give you "More Use per Dollar."

MANHATTAN RUBBER DIVISION—PASSAIC, NEW JERSEY

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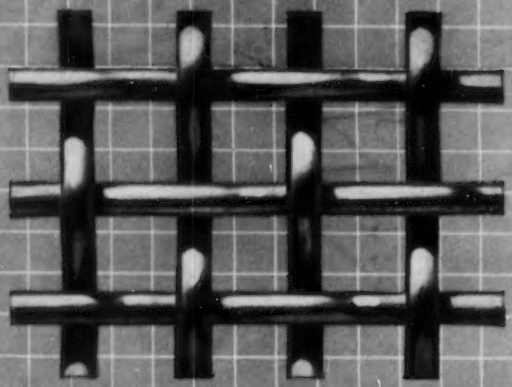
WICKWIRE ROPE

Known for its dependability for over half a century, Wickwire Rope is carefully controlled throughout manufacture to assure the maximum degree of strength, toughness and fatigue resistance—extremely important features in mining operations where the safety of men and protection of expensive equipment depend upon wire rope.

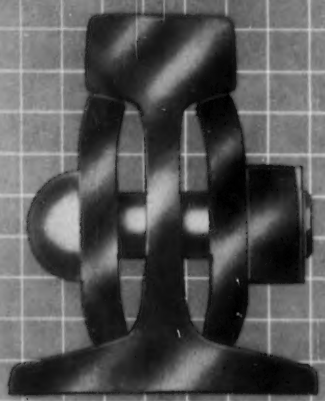


CAL-WIC INDUSTRIAL SCREENS

Woven to the most exacting tolerances, Cal-Wic Industrial Screens give unusually long life because they are tightly crimped to prevent hidden wear at the wire intersections. Wires can't work loose under even the most severe vibrations. Wide range of screen types and alloys available.

CF&I ROCK BOLTS

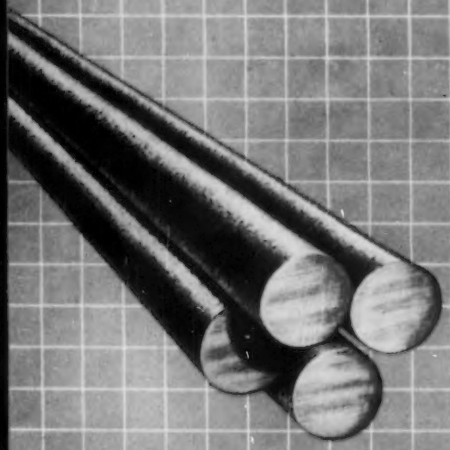
Enable progressive mine operators to economize and, at the same time, provide greater safety and better housekeeping in their mines. Available in either slot and wedge or expansion shell with Pattin shell types.



CF&I MINE RAILS AND ACCESSORIES

Available in the range of 12 to 45 pounds, CF&I Mine Rails meet A. R. A. standards. Accessories include splice bars, angle bars, spikes and track bolts and nuts (both square and hexagon).

2656



be sure!

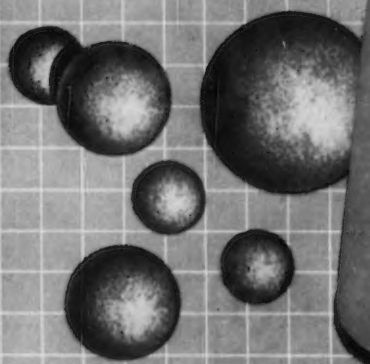
specify proven and dependable

CF&I MINING PRODUCTS

When you specify CF&I Mining Products, you are sure of receiving products that are perfectly designed for mining operations—for the complete line of CF&I Mining Products has been fully field-proven over many years of service and in our own mines. In addition, rigid quality controls give you positive assurance that CF&I Mining Products will provide trouble-free service throughout their long life.

CF&I GRINDING RODS

Rolled of special analysis steel, then carefully machine-straightened and cut to hold end taper to a minimum ... increase rod life. Equally effective for fine crushing or coarse grinding.



CF&I GRINDING BALLS

Forged of special analysis steel, CF&I Grinding Balls have built-in toughness to give optimum grinding ability and excellent wearability ... provide better power transmission and high impact-resistance.

THE COLORADO FUEL AND IRON CORPORATION—Denver and Oakland
WICKWIRE SPENCER STEEL DIVISION—New York, New York

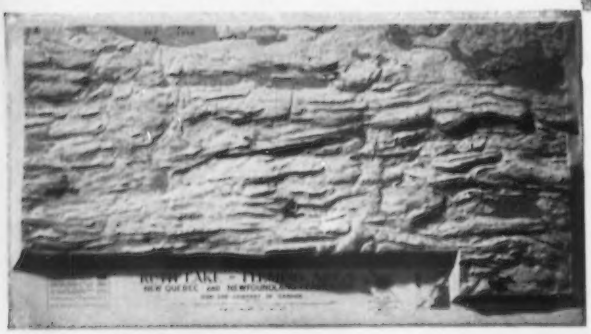
THE COLORADO FUEL AND IRON CORPORATION

CF&I

Important mineral finds are being uncovered by Aero clients with the airborne magnetometer

Precise aerial mosiacs provide valuable reconnaissance and planning data

Accurate Aero topographic maps aid engineering development



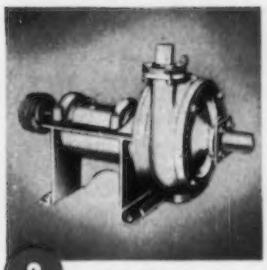
Light weight, plastic relief models give Aero maps a 3rd dimension for management

AERO's modern mining tools are cutting exploration and mapping costs . . . helping to locate new deposits of magnetite, ilmenite, nickel and asbestos . . . and putting schedules months and even years ahead. AERO maps are delivered speedily, and are so accurate, mining engineers are using them for plotting boreholes, property lines, rail spurs, access roads, power lines, and other phases of planning and development. Call on 37 years' experience of AERO—pioneer and leader in aerial surveys.

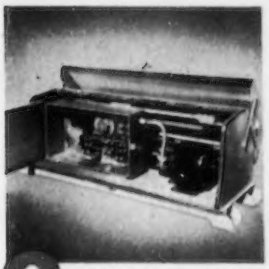
AERO SERVICE CORPORATION
PHILADELPHIA 20, PA.
Oldest Flying Corporation in the World

The indispensable 8

1 AGITAIR® FLOTATION MACHINE



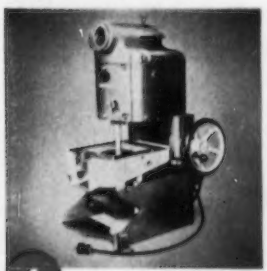
2 VACSEAL PUMP



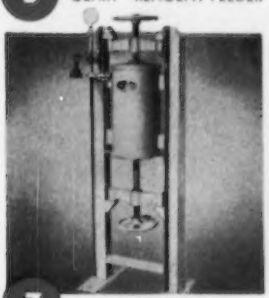
3 GEARY-JENNINGS SAMPLER

4 GALIGHER ACID-PROOF SUMP PUMP

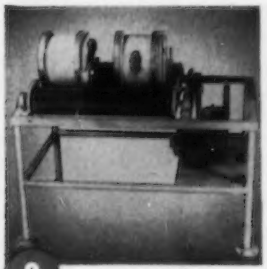
5 GEARY REAGENT FEEDER



6 500-1000-2000 GRAM LABORATORY AGITAIR®



7 LABORATORY PRESSURE FILTER



8 LABORATORY BALL MILLS

MACHINES for mill and laboratory

These eight rugged machines are the mainstays of ore beneficiation, with a tested precision that makes them standard equipment for laboratory, pilot plant or mill. Back of their design and manufacture is a half century of specialization in scientific tools for the metallurgist.

We invite correspondence from technicians in school laboratories and mills. Detailed information on any or all of these units will be provided freely and without obligation. Inquire also about our ORE TESTING SERVICE in a Galigher laboratory that is fully equipped and expertly staffed.

Leaders in Experience and Service

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Commercial and Laboratory AGITAIR®
VACSEAL PUMP
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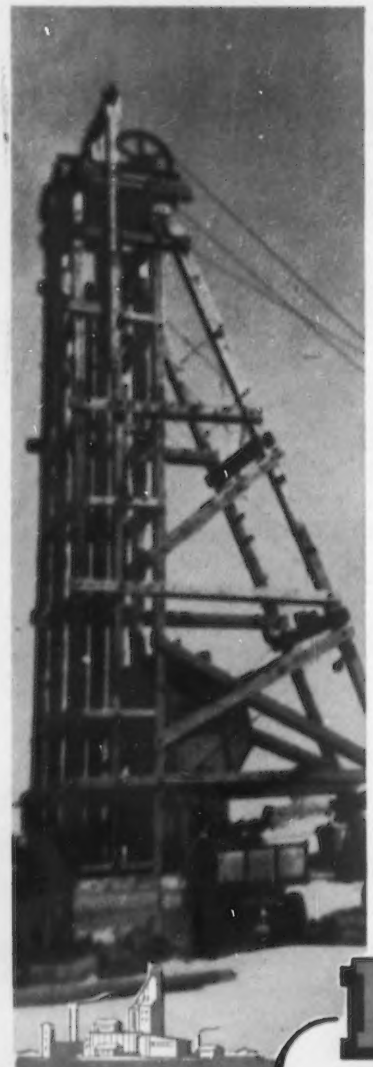

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TOURNATRACTOR is a 208 hp tractor that *runs* on rubber instead of *crawling* on tracks.

Since its *introduction in 1946,* this electric-controlled tractor has been used successfully in every kind of climate, terrain, material, and on every type of tractor application, all around the world, by *thousands of owners.*

Their *job records prove* that Tournatractors can outwork crawler-tractors by as much as 2 to 1 where job conditions allow the use of its higher speeds.

Remember, too, that for this extra speed and greater production capacity, plus all the other "bonus" Tournatractor advantages described below, *you invest no more,* and *pay less for operation and maintenance,* than for any crawler-tractor of similar power.

Does speed fit your job?

Check these advantages for your mine!

Speed on the job...
Tournatractor pulls, dozes, pushes at speeds 2 to 3 times faster than any crawler. You change gears instantly, waste no time shifting, go up to 8 mph in reverse.

Mobility between jobs...
Tournatractor travels job-to-job at high rubber-tired speeds. Big, low-pressure tires drive anywhere—you need no planking or trailers—have no loading or unloading delays.

Lower maintenance...
Lubrication takes only a few minutes a shift on Tournatractor as compared to 15 minutes or more on a crawler. No cleaning of tracks, grousers, and other fittings.

Fewer repairs...
A set of tires or tracks costs about the same. But tires last 2 to 3 times longer than tracks under most conditions . . . without the usual maintenance expenses.

Ample flotation, traction...
Each tire grips area approximately 2 feet wide. Lugs bite deep to give plenty of traction. Low-pressures increase flotation, absorb shocks, aid compaction.

Less loss of power...
208 hp diesel drives through dirt-sealed anti-friction bearings to free-rolling wheels. All gears and bearings automatically lubricated . . . all parts easily accessible.

Shifts instantly...
Constant-mesh transmission eliminates delays in changing gears . . . saves vital momentum . . . gives you any gear ratio instantly.

Torque converter available...
This simple, dependable, low-pressure system provides the equivalent of an infinite number of gear ratios automatically selected to best balance load and torque.

Easier to operate...
Less jolt and jar reduces stress and strain on both operator and machine. Fingertip electric controls let operator work faster, with less end-of-shift fatigue.

Improves safety...
Low center of gravity, all-around visibility, quick response of controls make Tournatractor exceptionally safe to operate. Multi-disc air brakes have more than *4 times* the braking surface of most big tractors and trucks.

Interchangeable equipment...
Bulldozer, Angledozer, Root Rake, Snow Plow—all interchangeable—may be mounted on Tournatractor. Tilt mechanism and down-pressure attachment also available.

Easy to keep busy...
Stripping overburden, pushing scrapers, cleaning up around shovels, or handling a wide variety of utility jobs around the pit, Tournatractor's speed and power will save you time and money.

Call or write us for a Tournatractor demonstration on your job. See for yourself the advantages of this versatile, high-speed, rubber-tired tractor.

Tournatractor—Trademark Reg. U.S. Pat. Off. T-733-M-b

Tournatractor pulls Carryall-Scrapers twice as fast as crawler-tractors. Hauls more in less time.

Versatile rig combines power and fast-positioning for efficient push-loading in any materials.

Tournatractor utilizes mobility and speed for quick clean-up around shovels and on pit floor.

LeTourneau-WESTINGHOUSE Company

Peoria, Illinois

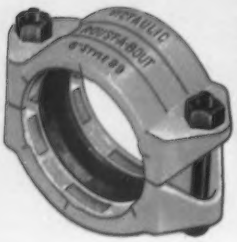
A Subsidiary of Westinghouse Air Brake Company

VICTAULIC®

METHOD OF PIPING

VICTAULIC HAS EVERYTHING...

VICTAULIC COUPLINGS
Simple, fast, reliable. *Styles 77, 77-D,* for standard uses with steel or spiral pipe, — *Style 75* for light duty. Other styles for cast iron, plastic and other pipes. Sizes ¾" to 60".

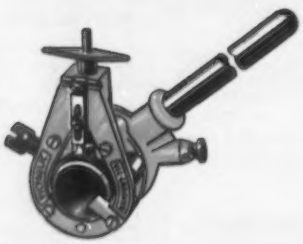


ROUST-A-BOUT COUPLINGS
For plain or beveled end pipe *Style 99.* Simple, quick, and strong. Best engineered and most useful plain end coupling made — takes a real "bull-dog" grip on the pipe. Sizes 2" to 8".

VICTAULIC SNAP-JOINTS
The new, boltless, speed coupling, *Style 78.* Hinged into one assembly for fast piping hook-up or disassembly. Hand locks for savings in time and money. Ideal for portable lines. Sizes 1" to 8".

COUPLINGS FOR EVERY PIPING JOB

VICTAULIC FULL-FLOW FITTINGS
Elbows, Tees, Reducers, Laterals, *a complete line*—fit all Victaulic Couplings. Easily installed — top efficiency. Sizes ¾" to 12".



VIC-GROOVER TOOLS
Time saving, on-the-job grooving tools. Light weight, easy to handle — operate manually or from any power drive. Sizes ¾" to 8".

PLUS FITTINGS AND GROOVING TOOLS

"EASIEST WAY TO MAKE ENDS MEET"

Promptly available from distributor stocks coast to coast.
Write for NEW Victaulic Catalog-Manual No. 55-I

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Are You Seeking New Ideas On OPEN-PIT MINING?

Be sure to check through pages 39-68 of this Guidebook for the latest developments in:

- Shovels and Draglines
- Scrapers
- Front-End Loaders
- Tractors and Trucks
- Engines and Accessories
- Mine Cars
- Locomotives
- Drilling Units
- Drill Bits

For manufacturers of equipment, materials and supplies used in open-pit mining, see the BUYERS' GUIDE SECTION of this Guidebook—the most up-to-date and complete BUYERS' GUIDE available in the Industry.

Manufacturers advertising in this issue appear in bold-faced type. You'll find more useful information in their advertisements.

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Why the Big "B" Rear-Dump

can cut your hauling costs

Speeds to 34 mph

The new 35-ton capacity B Tournapull Rear-Dump has 10 forward speeds, from 2 mph to 34 mph . . . 2 reverse speeds, 2 and 4 mph. Rapid shift and quick acceleration of 293 hp diesel engine lets you move faster and easier into higher gear ranges.

Improved gradability

Proper distribution of weight forward onto drive wheels allows "B" to go up steep grades.

Fast loading

Large "target" area makes loading fast and simple. Bowl is 17'8" long, 10'2" wide, has maximum depth of 7'6". Rear of body provides wide, low entry which gives excavator faster loadings.

Fingertip control of dumping

The touch of a switch, activates hoist motor to lift body. As body lifts quickly, it swings behind rear wheels to dump clean. Completely streamlined bowl sheds material readily. There is positive control both up and down.

Rugged Construction

Body is heavy steel plate, rigidly reinforced. Three layer bottom consists of heavy bottom plate, thick steel billets and heat treated steel strips to resist wear. Main case of prime-mover is built extra strong . . . will not distort to put strain on power-train.

No hydraulics, springs or hinged steering connections

Problems of conventional rear-dumps are eliminated by simple design of "B" Rear-Dump. Troublesome hydraulics, long driveshafts, springs, spring hangers and hinged steering connections are eliminated. Improved hauler means higher mechanical efficiency and lower maintenance costs on all hauling jobs.

Ask for complete information on how this unit can be interchanged with a Scraper or Crane, at about 25% of original total price.

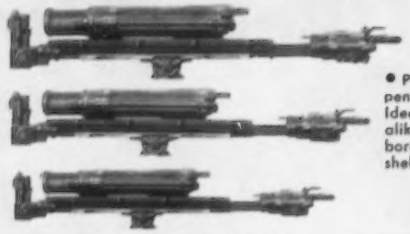
Now available with optional tailgate.

Tournapull—Trademark Reg. U.S. Pat. Off. BR-889-G-b

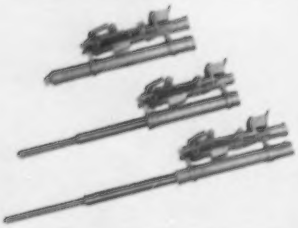
LeTourneau-WESTINGHOUSE Company

Peoria, Illinois

A Subsidiary of Westinghouse Air Brake Company

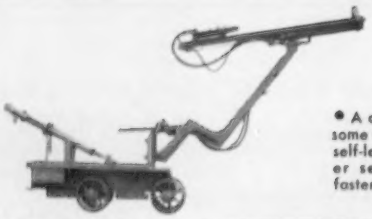


• Power-feed drifters. Dependable, powerful, and fast. Ideal for columns and jumbos alike. 3 sizes up to 4-inch bore. Also aluminum guide shells to 60-inch change.



• Stopers for every need — 75-lb., 90-lb., and 120-lb. sizes, and a complete line of offset stopers with 36-inch steel changes for deep holes, or with short feeds for confined spaces. Conventional or telescopic feeds.

• A complete line of sinkers from 18 to 80 lbs. including the popular 45-lb. H10, and 55-lb. H111.



• A complete line of Jumbos, some with air-motor powered, self-leveling booms for quicker set-ups, greater safety, faster rounds.

• One-use detachable bits for sinkers, drifters and stopers. Special offset-gauge feature reduces binding and provides extra clearance for cuttings so that drilling speeds are faster. No rods to thread — just a simple taper connection.

• The Cleveland Air Leg can be used as a stoper, a drifter, a sinker. Supports sinker and also provides feeding pressure for faster, easier drilling. 3', 4', and 5' feed legs. Full range of drill rotations. Only one air hose required. Convenient feed-leg control valve gives any desired feeding pressure. Bayonet lock permits quick dismantling for easy transportation. Conventional or telescopic feeds.

• Air-feed sinkers — 2-way feed, 2 sizes. They take the back-breaking work out of drilling horizontal holes, lighten the load on your miners, and increase tonnages.

• The SDR 34 shaft sinker for faster shaft sinking. Available with two or four drills. All adjustments quickly made with air motor.

High Drilling Speed, Low Upkeep, Easy Handling Are Key Features of Le Roi-Cleveland Rock Drills

. . . and there's a size and type for every drilling operation in a mine

We've been designing and building rock drills for the mining industry since 1906. During this time we've pioneered many firsts — and during this time, you have taught us a great deal about your drilling problems.

Perhaps just as important as experience is the fact that building rock drill equipment is our only business. And building the best rock drills is our sole desire.

Today's Le Roi-Cleveland Drill is the product of this desire. As you look over the line-up shown here, you won't find a single machine that isn't a top performer in its rock-drill class.

Why? Because drilling speed, powerful rotation, and dependable durability are inherent in all Le Roi-Cleveland tools. Moreover, operators generally like them because they're easier to run.

This all adds up to more feet of hole drilled per shift, increased man-shift production, and lower costs.

We know that drilling costs are only a small part of your total cost picture. But we also know that you are interested in cutting any cost, no matter how small. We suggest, therefore, that you try Le Roi-Cleveland Drills — there's a size and type for every drilling operation. If you need additional information, just write us.

LE ROI Division of Westinghouse Air Brake Co., Milwaukee 1, Wisconsin, manufacturers of Cleveland Rock Drills.

RD-64

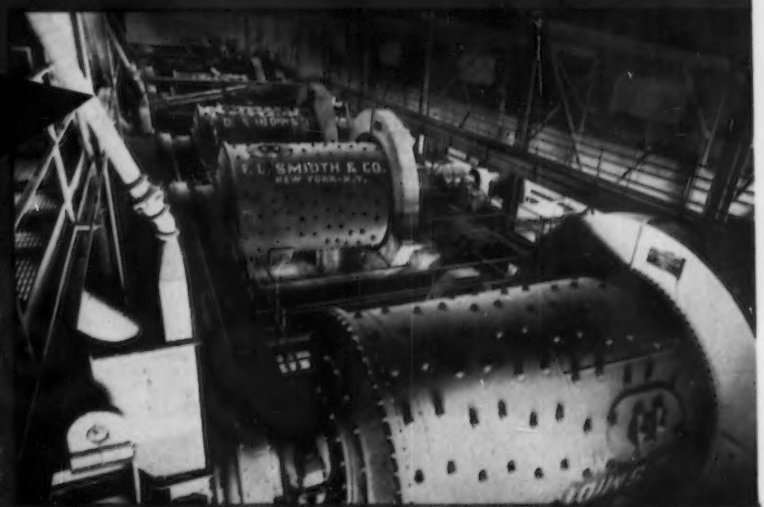
SMIDTH

Rotary Kilns

For sintering, nodulizing, calcining, desulphurizing, oxidizing and reducing roasting—coolers, precoolers, preheaters, recuperators—and auxiliary equipment.

Grinding Mills

Ball mills, tube mills and multicompartment mills—open or closed circuit—wet or dry grinding also airswept for grinding and drying.



Over 1,000 Smidth Rotary Kilns and over 5,000 Grinding Mills supplied all over the world.

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Be sure to check through pages 102-145 of this Guidebook for the latest developments in:

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The Engineer's Report

CASE HISTORY

PRODUCT RPM Delo Oils

FIRM Bagdad Copper Corp., Bagdad, Arizona

Biggest truck in the world uses RPM DELO Oil!

246,000 POUNDS TOTAL LOAD, 48 tons of truck and 75 tons load, are hauled out of the Bagdad Copper Corp.'s ore pit at Bagdad, Arizona, by the two 350 h.p. supercharged diesels in this unit. RPM DELO Special Lubricating Oil is used in the engines as specified by Mr. Ernest Dickie, General Manager of Bagdad, on the basis of his years of experience with RPM DELO Oils in many other heavy-duty engines.

The big truck, described as the largest in the world, was designed by Mr. Dickie and engineers of Dart Truck Co., builders. Power is transmitted through 3-stage torque converters. All controls are powered.

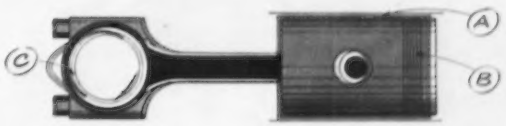
FREE FOLDER tells you about all the RPM DELO Oils and how they meet every heavy-duty engine condition. Write or call for it today.

FOR MORE INFORMATION about petroleum products of any kind or the name of your nearest distributor, write or call any of the companies listed below.

RPM DELO LUBRICATING OILS

TRADEMARKS "RPM DELO" REG. U. S. PAT. OFF.

How RPM DELO Oils reduce wear, corrosion, oxidation in all heavy-duty engines



A. Contain special additives that provide metal-adhesion qualities...protect parts whether hot or cold, running or idle.

B. Anti-oxidant resists deterioration of oil and formation of lacquer...prevents ring sticking. Detergent keeps parts clean...helps prevent piston scuffing.

C. Special compounds stop corrosion of any bearing metal and foaming in crankcase.

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THE CALIFORNIA COMPANY
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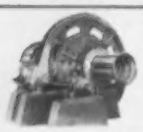
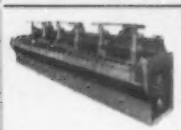
Complete DENVER MILL EQUIPMENT

One source . . . one responsibility

		SIZES		WRITE FOR
DENVER (Patented) **SUPER AGITATORS & CONDITIONERS**		3′ x 3′ to 20′ x 20′	Patented standpipe around propeller shaft assures positive agitation and circulation. Patented weir collar prevents sand-up on shut-down. Heavy-duty as well as acid-proof construction is available.	Bulletin No. A2-B4
DENVER Steel-Head **BALL MILLS**		3′ x 2′ to 7′ x 16′	A Denver Steel-Head Ball Mill will suit your particular need. Five types of discharge trunnions. All-steel construction. Low initial cost due to quantity production. Quick delivery. Laboratory and pilot plant mills also available.	Bulletin No. B2-B13
DENVER Forced-Feed **JAW CRUSHER**		2¼″ x 3½″ to 36″ x 48″	Cast steel frame, manganese jaw and cheek plates. Large diameter shafts reduce shaft deflection and thus increase life of heavy-duty, oversize roller bearings in bumper. Setting easily controlled.	Bulletin No. C12-B12
DENVER Spiral **CLASSIFIER**		6″ Simplex to 60″ Duplex	Has many improvements. For instance, lower bearing placed above pulp level, arrangement of feed, overflow and direction of rotation result in maximum efficiency. Rake-type and Denver-Finney classifiers also available.	Bulletin No. C5C-B
DENVER Selective **MINERAL JIG**		4″ x 6″ Simplex to 36″ x 48″ Duplex	An improved, pulsating, gravity selector that treats unclassified, unsized feed and recovers minerals as soon as freed. Easy to regulate and control, minimum attention. Use in closed grinding circuit or open circuit.	Bulletin No. J2-B10
DENVER Disc **FILTERS**		2′ dia. x 1 Disc. to 9′ dia. x 8 Disc.	Special, patented design of segments in Denver Disc Filters use both gravity and vacuum to give a drier filter cake. Drainage is complete and positive, with no blow-back. Simple, low-cost, dependable construction. Quick delivery. Also Drum and Pan Filters.	Bulletin No. F9-B2
DENVER "Sub-A" **FLOTATION**		16″ x 16″ to 56″ x 56″	More large plants are installing Denver "Sub-A's" for their entire flotation job — roughing, scavenging, cleaning and re-cleaning — because they give maximum recovery at a low cost per ton. Dependable, low-cost, simplified continuous operation.	Bulletin No. F10-B81
DENVER SRL **SAND PUMPS**		Up to 2400 G.P.M.	Pressure-molded rubber parts, accurately engineered, give high efficiency at low horsepower. DECO also manufactures Denver Vertical Sand Pumps, and Adjustable Stroke Diaphragm Pumps.	Bulletin No. P9-B8
DENVER Automatic **SAMPLERS**		16″ to 60″ Cutter Travel	Extra rigid track and ball-bearing wheels assure positive travel and timing of sample cutter. Denver Vezin Type, Denver Snyder Type, or complete sampling systems available. Standard, low cost.	Bulletin No. S1-B4
DENVER Dillon **SCREENS**		1′ x 3′ to 6′ x 14′	Gives fast, clean separation without blinding. Gives even, smooth flow of material because of the patented "true-circle" eccentric action. Two bearing construction saves 50% HP.	Bulletin No. S3-B11
DENVER Spiral Rake **THICKENER**		3′ x 3′ to 125′ x 16′	Enclosed, running-in-oil head motion. Patented spiral rakes move settled solids to center discharge with continuous motion, rapid removal of solids tends to eliminate overload. Wood, Steel or rubber-covered Tanks available.	Bulletin No. T5-B5

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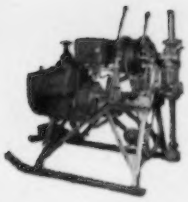
DENVER EQUIPMENT COMPANY

1400 SEVENTEENTH STREET DENVER 17, COLORADO PHONE CHerry 4-4466

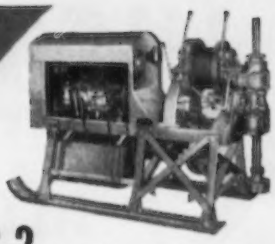


BBS-1

World's best known surface drill. Handles "E" Rods to 1,500 ft., "A" to 1,100 ft.

X-ray

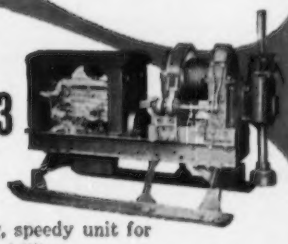
Compact, portable—185 lbs. net. Takes ¾" core to 200 ft. Low fuel consumption.



BBS-2

Versatile, choice of 5 swivelheads. Depths to 3,500 ft. Gas or diesel.

BBS-3



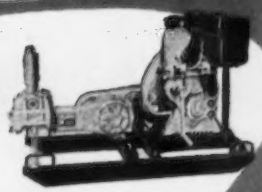
Strong, speedy unit for deep drilling . . . 4,600 ft. with "A" Rods, 3,800 ft. with "B" Rods, 95 h.p. diesel.

BBS-4

Drills to 5,000 ft. with "B" Rods. Moves under own power, gas or diesel.

if it's for diamond drilling we make it!

drill pumps



5-12 and 4-7 models. Capacities 400 to 1,200 g.p.h. Diesel motor optional.

permaset bits

(Powdered metal)

All standard sizes available from stock. Also reaming shells, etc.

JV

4 feed swivelhead. Capacity 800 ft. with "E" Rods. JVR with right-hand feed screw for blastholes.

BBU-2

Rugged. Capacity 1,800 ft. with "E" Rods, 1,400 ft. with "A", four gear speeds.

VEG

Vane motored version of J.V. Lightweight, compact construction. Can be speedily dismantled into two units.

BOYLES BROS
DRILLING COMPANY LTD.
VANCOUVER, CANADA

BOYLES BROS. (PTY) LTD., JOHANNESBURG, SOUTH AFRICA • BOYLES BROS. DRILLING CO. LTD., NEWCASTLE-ON-TYNE, ENGLAND • ATLANTIC, GULF AND PACIFIC CO. OF MANILA, PHILIPPINES • SHRIRO TRADING CO. S.A. TOKYO, JAPAN • FORMAC S.A. RIO DE JANEIRO, BRAZIL • WEISE AND CA. LDA., LISBON, PORTUGAL • I. H. HANNA, 331 SANTA CRUZ, SAN ISIDRO, LIMA, PERU • R.I.E.G.A. BUENOS AIRES, ARGENTINA • HAEHRE AND CO. A/S. OSLO, NORWAY • INTERNATIONAL MACHINERY CO., SANTIAGO, CHILE DIMITRY SCALISTIRI, ATHENS, GREECE • THOMAS M. NEVIN, Y. CIA. S.A MEXICO, D.F.

VICTAULIC®

METHOD OF PIPING

VICTAULIC HAS EVERYTHING...

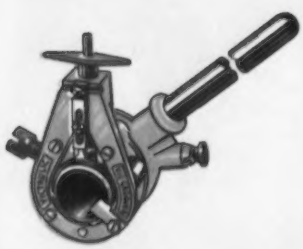
VICTAULIC COUPLINGS
Simple, fast, reliable. *Styles 77, 77-D,* for standard uses with steel or spiral pipe, — *Style 75* for light duty. Other styles for cast iron, plastic and other pipes. Sizes ¾" to 60".

ROUST-A-BOUT COUPLINGS
For plain or beveled end pipe *Style 99.* Simple, quick, and strong. Best engineered and most useful plain end coupling made — takes a real "bull-dog" grip on the pipe. Sizes 2" to 8".

VICTAULIC SNAP-JOINTS
The new, boltless, speed coupling, *Style 78.* Hinged into one assembly for fast piping hook-up or disassembly. Hand locks for savings in time and money. Ideal for portable lines. Sizes 1" to 8".

COUPLINGS FOR EVERY PIPING JOB

VICTAULIC FULL-FLOW FITTINGS
Elbows, Tees, Reducers, Laterals, *a complete line*—fit all Victaulic Couplings. Easily installed — top efficiency. Sizes ¾" to 12".



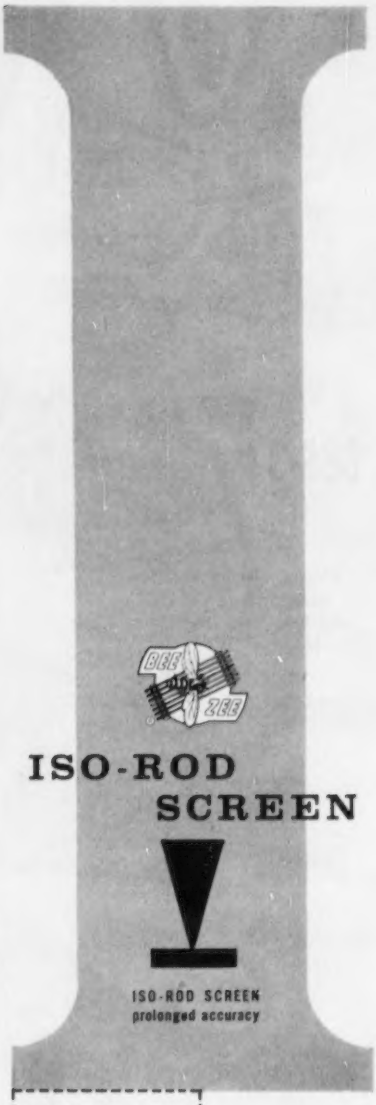
VIC-GROOVER TOOLS
Time saving, on-the-job grooving tools. Light weight, easy to handle — operate manually or from any power drive. Sizes ¾" to 8".

PLUS FITTINGS AND GROOVING TOOLS

"EASIEST WAY TO MAKE ENDS MEET"

Promptly available from distributor stocks coast to coast.
Write for NEW Victaulic Catalog-Manual No. 55-1

VICTAULIC COMPANY OF AMERICA
P. O. BOX 509 • Elizabeth, N. J.



Iso-Rod Screen is new...and it's covered in the new BIXBY-ZIMMER SCREEN BOOK just off the press. Write, or phone for your free copy.

Better find out about these screens that are 100% stainless steel...electronically precision-welded...won't rust or corrode ...can be fitted to any equipment.

BIXBY-ZIMMER
ENGINEERING COMPANY
566 Abingdon Street, Galesburg, Illinois

The makers of the famous Liddicoat single-use Steel Bit announce an interesting completely new line of tungsten carbide insert bits. (Patents applied for).

The new Liddicoat TEE CEE Bit is "drilled to destruction without resharpening"

The bit drills to destruction without developing a reverse taper dullness.

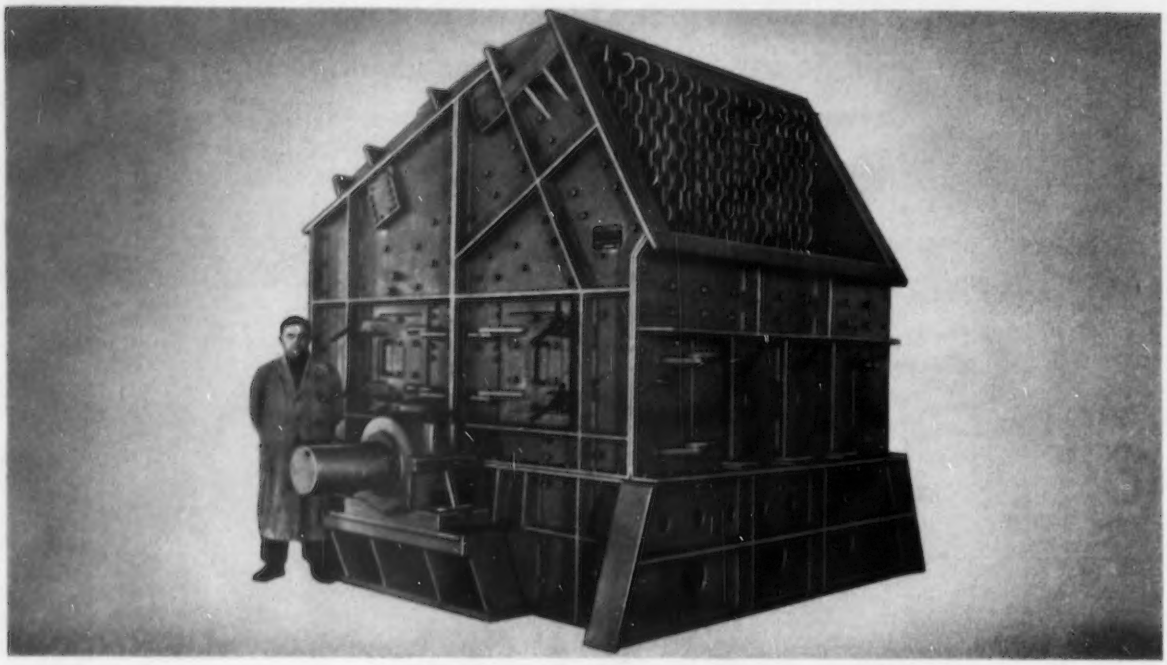
No threads—forged for strength.

A new low first cost—lowest cost per foot of hole drilled.

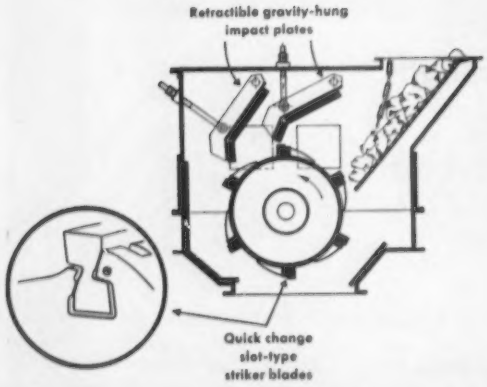
For information, contact your Liddicoat dealer or Western Rock Bit Manufacturing Co.

WESTERN
Rock Bit Manufacturing Company
552 West 7th South • Salt Lake City 4, Utah

WIDER HORIZONS



FOR IMPACT CRUSHING



HAZEMAG IMPACT CRUSHERS utilize heavy rotating masses, lower impact speeds, and "open" construction to reduce blade and liner wear. It is now economically practicable to crush **BY IMPACT** a wide range of ores and minerals, with these benefits:

- **High Reduction Ratio**—HAZEMAG "multi-stage" crushers usually eliminate one or more stages—save on initial equipment cost.
- **Sturdy and Simple Construction** (only one moving part)—saves on maintenance.
- **Selective Crushing** (the hall mark of the impactor)—takes full advantage of natural cleavage—assures better ore pre-concentration—lower grinding cost.
- **Foreign Bodies**—a simple mechanism provides sure-fire protection.
- **High capacity**—Small space requirement—Light foundation.

OVER 1200 HAZEMAG IMPACT CRUSHERS NOW INSTALLED ALL OVER THE WORLD

HAZEMAG M·B·H· IMPACT CRUSHERS RAPID DRYERS

HAZEMAG

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International Industrial Sales
122 East 42nd Street
New York 17, New York

IN MEXICO
DIESEL MEXICANA, S.A.
Reforma 20, Desp. 102,
Mexico D.F. City

Munster (Westf.) Germany

Cedarapids Built by IOWA

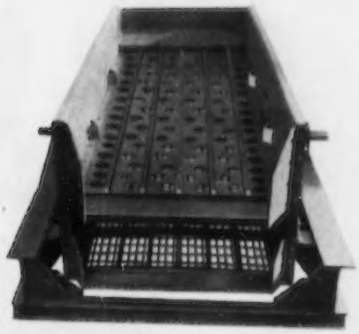
HEAVY-DUTY EQUIPMENT FOR CUTTING PROCESSING COSTS

Cedarapids equipment is engineered with all the features essential to low-cost ore handling. Each unit is built for the *extra strength* necessary for heavy-duty service in the world's most rugged industry. Each unit is designed by experts in the field for *high capacity* production. The "proved-in-service" *low maintenance* costs of Cedarapids equipment is another bonus feature that helps you cut processing costs. Investigate Cedarapids advantages today!

HEAVY-DUTY APRON FEEDERS

ASSURE SMOOTH, WORKABLE FLOW OF ORE

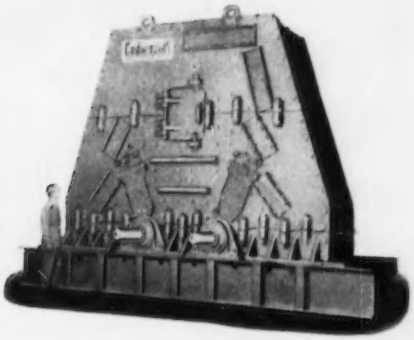
This big 40″ x 12′4½″ Apron Feeder is especially designed for smooth feeding of heavy, large-size material. Rugged construction, with 9 shafts beneath the heavy cast steel flights, withstands the dumping of heavy loads into the feeder.



HEAVY-DUTY SCALPING SCREENS

COMBINE BIG-VOLUME PRODUCTION WITH LOW MAINTENANCE COSTS

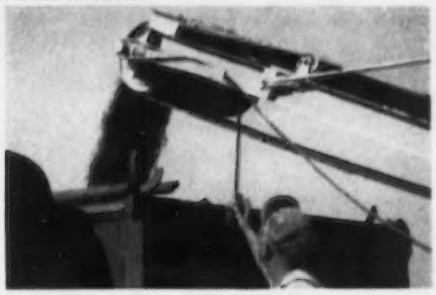
Cedarapids Inclined Double Deck Vibrating Screens are sturdily built to handle 2 to 3-ft. material. Eccentric shaft vibrating mechanism provides positive circle throw to assure big-volume output. Easily replaceable plate feed box and discharge lip reduce maintenance costs.



DOUBLE IMPELLER IMPACT BREAKERS

FOR PRIMARY AND SECONDARY CRUSHING IN ONE OPERATION

Double Impeller Impact Breakers are being used for more and more mining applications because of their exceptionally high output, design which permits a high percentage of material to be broken in suspension to minimize wear and reduce power requirements and the high reduction ratios which eliminate the need for secondary crushers in many instances. It will pay you to investigate all the many other advantages of Double Impeller Impact Breakers.



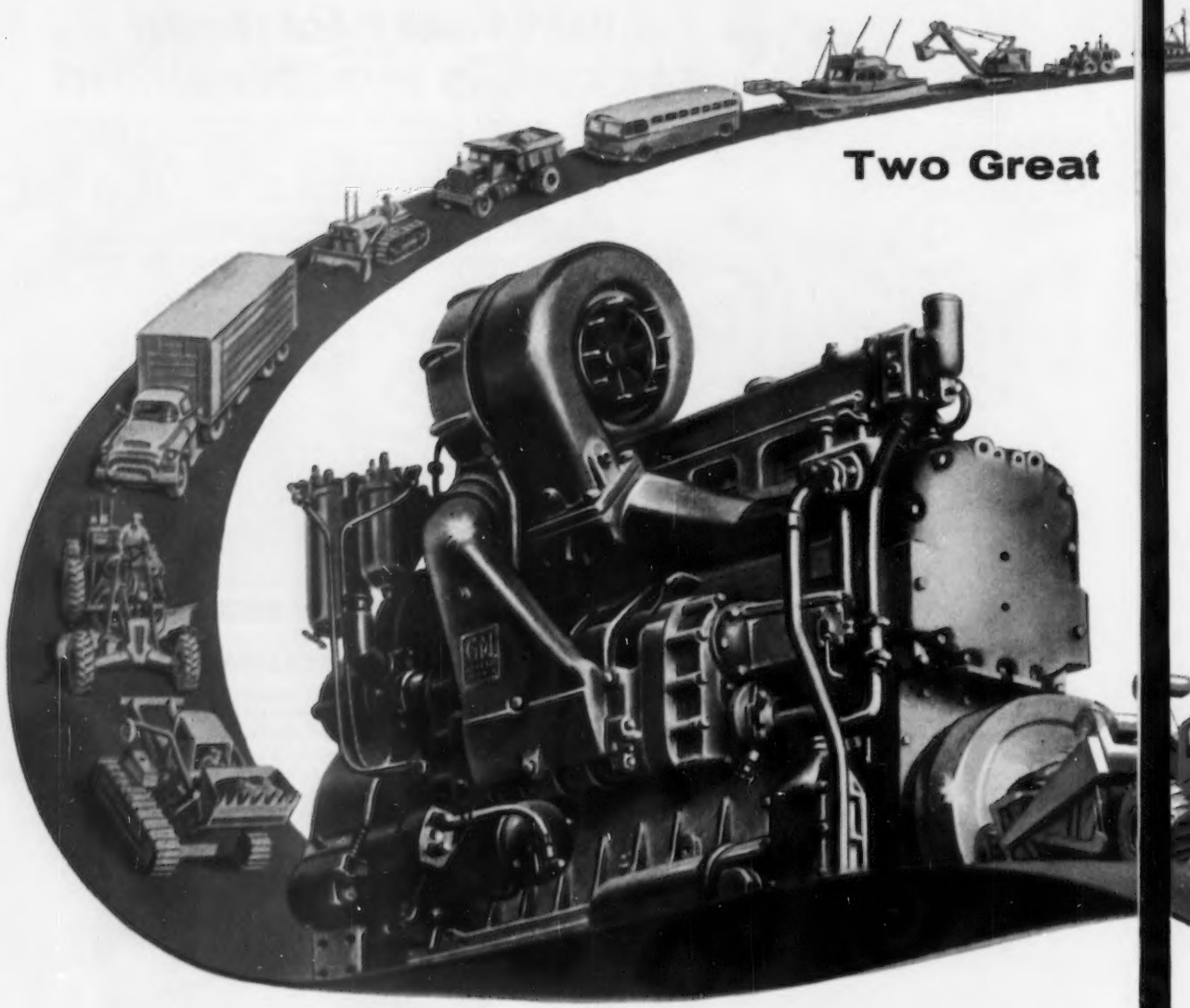
MOTORIZED HEAD PULLEYS

CUT CONVEYOR MAINTENANCE COSTS 70 TO 90%

Everything is contained inside the pulley shell! The complete elimination of chains, sprokets, V-belts, jack shafts, etc. eliminates 70 to 90% of conveyor maintenance costs. More and more mining companies are modernizing their conveyor systems with these revolutionary *Motorized* Pulleys to cut costs.

See your nearest Cedarapids Distributor for complete details

IOWA MANUFACTURING COMPANY
Cedar Rapids, Iowa, U.S.A.



Increased Power—Decreased Fuel

Here's exciting news for power users—great new 4- and 6-cylinder GM Detroit Diesel engines that represent another long forward step by the leader in the Diesel engine field. With this new, more efficient Detroit Diesel Turbopower you can have up to 17% more power with no increase in fuel consumption—or the same power output with fuel saving up to 15%.

Detroit Diesel engineers have Turbo-charged 2-cycle Diesels by combining an exhaust-driven turbine with the engine blower to deliver a larger supply of fresh air to the cylinders. Result: improved combustion, freer engine breathing, quieter and more efficient performance in the higher speed ranges.

Turbopower Diesels are additions to Detroit Diesel's time-proved Series 71 line, world's most widely used Diesel engines. The four-cylinder Turbopower Diesel delivers 171 H.P. at 2300 R.P.M.; the six-cylinder engine produces 280 H.P. at 2300 R.P.M.

To truckers Turbopower means speedier, more economical movement of big payloads.

To boatmen it means faster speed or longer cruising range—more room for cargo.

To contractors and other industrial users it means greater work output from higher-powered engines or improved economy.

For the full story of 2-cycle Turbopower, write us or call your nearest GM Detroit Diesel Distributor or Dealer.

AMERICA'S LARGEST BUILDER OF DIESEL ENGINES

New Engines Added
to General Motors 2-cycle Diesel Line

Detroit Diesel Turbopower

LIPPMANN *Rock Ram Jaw Crushers*

30x36 Rock-Ram crushing plant in Ohio includes Lippmann feeder, conveyors, screens, pulverizer and bins.

10x36 Rock-Ram crusher in a stationary crushing plant in Illinois. Also includes Lippmann feeder, conveyors and screens.

20x36 Rock-Ram mounted on primary plant with feeder and conveyor, in an Illinois pit.

IT'S THE BEST CRUSHER INVESTMENT I'VE EVER MADE...

"We have operated our Lippmann Crushing Plant for almost a year now and your 24x36 Rock-Ram jaw crusher mounted on it is a real rock breaker. It requires practically no attention, uses little power and will take all we can give it and more. It's the best crusher investment I've ever made."

(signed)
WILMER GERDES,
owner
GERDES QUARRY,
Dixon, Ill.

Mr. Gerdes' praise of his Lippmann Rock-Ram is typical of the pride voiced by Rock-Ram owners everywhere. And with good reason — for each has a machine that, pound for pound, is the strongest crusher built. And better than this are other Rock-Ram advantages . . . heavier flywheels and greater crushing-stroke eccentricity to give more impact and bigger bite for greater production and lowest power usage . . . larger shaft and oversize roller bearings that assure longer uninterrupted service with less chance of the shaft and bearing failures that makes ownership of ordinary crushers so expensive. The feed opening is specially engineered larger with size measured at the closed stroke of the eccentric instead of the open. This gives Rock-Ram owners the added bonus of a greater-than-specified opening size.

The Rock-Ram owner also knows that his crusher has many of the same superior crushing advantages of the famous Lippmann Grizzly-Kings — but at Rock-Ram's lower cost. Small wonder that Mr. Gerdes says, "It's the best crusher investment I've ever made."

Rock-Rams are made in sizes 10" x 16" to 30" x 36". Bulletin 1111 contains full information on these superb crushers. Contact your Lippmann Distributor, or write to Lippmann Engineering Works, 4623 W. Mitchell St., Milwaukee 14, Wis.

1111-56-4

LEW **LIPPMANN**

SINCE 1923

CRUSHERS FEEDERS SCREENS CONVEYORS CRUSHING & WASHING PLANTS

Quality-built for dependable, high-output stripping and loading...

the big, rugged LIMA Type 2400

It takes a big, rugged machine like the Type 2400 to give you fast, dependable, high-output stripping and loading service. This heavy-duty 6 yd. shovel is quality-built by Lima to stay on the job, deliver peak operating performance on the tough assignments. It's easily convertible for dragline operation, too.

Air operated clutches make the Type 2400 easy to handle. Wide, long crawlers give it plenty of bearing area for stability and maneuverability on soft footing. Tandem mounted drums give maximum cable capacity. These plus Lima's quality "extras" (see right) have made the Type 2400 a hands-down favorite with users around the world.

Get the full story on the quality-built Type 2400 today. See your nearby Lima distributor, or write Construction Equipment Division, Baldwin-Lima-Hamilton Corporation, Lima, Ohio.

COMPARE QUALITY! No other machine gives you as much as LIMA!

1. Piston-type dirt seal rings and retainers in crawler rollers.
2. Moving parts are flame or induction hardened for longer life.
3. Two-shoe swing and propel clutches; air control.
4. Anti-friction bearings at all important bearing points.
5. Big capacity drums and sheaves are easy on cables.
6. Propel and swing gears and power take-off are enclosed in a sealed oil bath.
7. Torque converter (standard equipment).
8. Wherever you are, you can depend on skilled service and nearby warehouse stocks of parts to keep your LIMA on the job continuously.

COMPARE and you'll specify LIMA for shovels (½ yd. to 6 yds.), cranes (to 110 tons) and draglines (variable). Smaller capacities available on rubber.

DISTRIBUTORS IN PRINCIPAL CITIES OF THE WORLD

BALDWIN BLH LIMA-HAMILTON

LIMA SHOVELS · CRANES · DRAGLINES · PULLSHOVELS

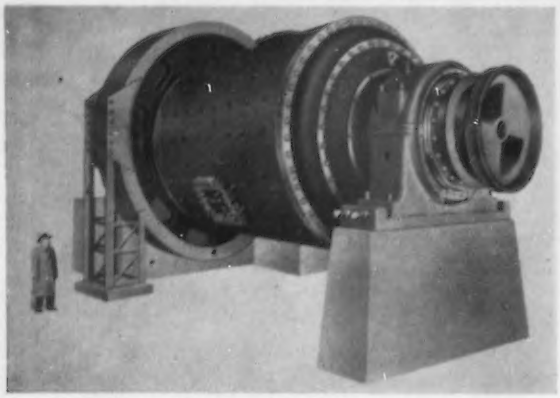
BALDWIN-LIMA-HAMILTON

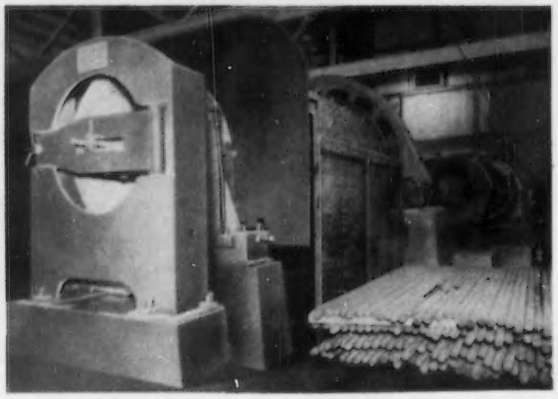
Construction Equipment Division • LIMA WORKS

OTHER DIVISIONS: AUSTIN-WESTERN • EDDYSTONE • ELECTRONICS & INSTRUMENTATION • HAMILTON • LOEWY-HYDROPRESS • MADSEN • PELTON • STANDARD STEEL WORKS

THE DIRECTORY OF

MARCY GRATE DISCHARGE BALL MILLS AND MARCY OPEN END ROD MILLS

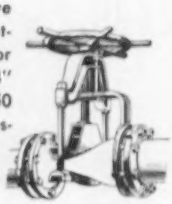




Marcy Ball and Rod Mills both incorporate the Marcy principle of grinding..."rapid change of mill content is necessary for high efficiency." This is accomplished by use of the Marcy *full-grate* discharge on ball mills and the *open end* feature on Marcy rod mills. These features result in a low pulp line which provides an active, effective grinding mass to act on particle size reduction only... there is no wasteful cushioning action by high pulp levels. There is a faster migration of fines than oversize particles, thus less overgrinding. This basic principle of grinding incorporated in Marcy Mills has proved, in hundreds of installations, to give greater output with lower KWH per ton, from 25 to 45% more tonnage compared with the same size overflow mills. Marcy Mills are made in sizes up to 12' 6" diameter. Every Marcy is backed by more than 40 years grinding experience.

MASSCO-GRIGSBY RUBBER PINCH VALVES

Designed for abrasive and corrosive pulps. Patented hinged sleeve for longer wear. 1" to 14" diameter. Up to 150 pounds continuous pressure.



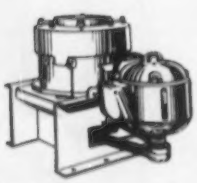
WILFLEY TABLES

For separation of any ore or material amenable to gravity concentration. Laboratory and commercial sizes, up to 75 tons capacity per 24 hours.

MARCY PULP DENSITY SCALE

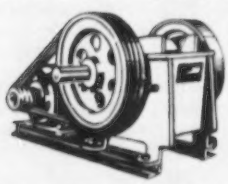
Gives DIRECT READING of weight of sample in grams or kilograms; specific gravity of liquid, specific gravity of pulp; percent solids contained in a pulp of any given specific gravity; specific gravity of dry solids. Is very accurate and easy to keep clean.

LABORATORY EQUIPMENT



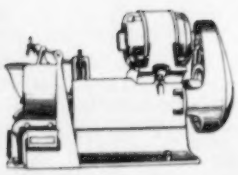
MASSCO GY-ROLL REDUCTION LABORATORY CRUSHER

Reduces ½" feed to as fine as 10 mesh in single pass. High capacity with low power consumption. 6" and 10" sizes.



MASSCO LABORATORY JAW CRUSHER

Welded steel frame; manganese steel jaw and check plates; bronze bushed bearings; smooth jaws give better product and easier cleaning. Adjust for plate wear by convenient hand wheel.

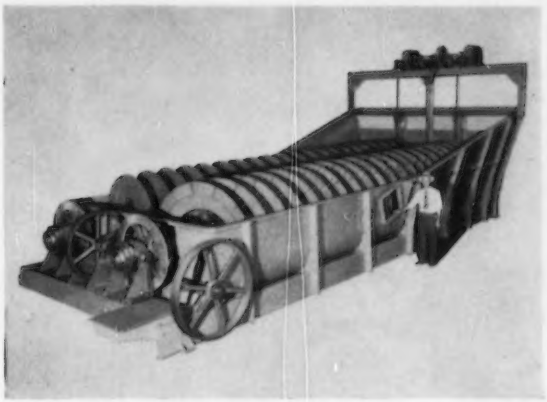


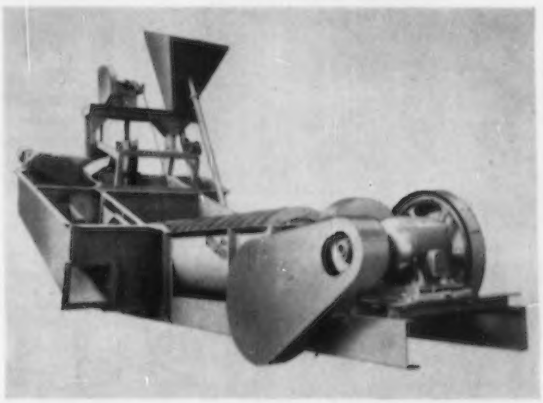
MASSCO-McCOOL PULVERIZERS

Disc type grinder with planetary movement. No gears. Will grind to 150 mesh in one pass.

COST-CUTTING EQUIPMENT

AKINS CLASSIFIERS AND HEAVY MEDIA SEPARATORS

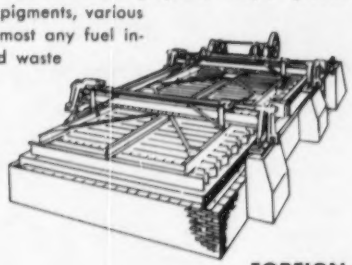




The Akins Classifier was originally developed, in 1908, for use in closed circuit with a ball mill. Its outstanding success led to many other profitable applications where it has demonstrated its superiority... dewatering and recovering fine solids; sand and slime separations; washing coal, sand, and oyster shell; desliming and de-oiling phosphate rock and concentrate; sink-float concentration; and many others. The Akins is made in sizes up to 84", simplex and duplex, in two types—small and large settling pool. The Akins Heavy-Media Separator is the only unit available which can make a 3-product separation in one machine from one medium cleanup circuit.

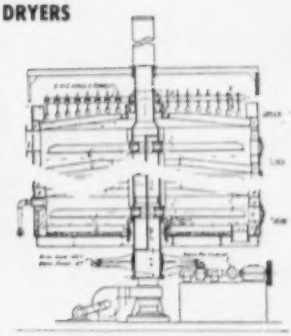
LOWDEN DRYER

For drying flotation concentrates, graphite, clays, ground minerals, paint fillers, pigments, various precipitates. Can use most any fuel including live steam and waste heat.



SKINNER ROASTERS AND DRYERS

For roasting, calcining, and drying ores, clays, limestone, limestone mud, flotation concentrates; decomposing oil sludge in the process of recovering sulphuric acid. Coal, oil or gas fired. Sizes to 22' inside diameter; up to 12 hearths.



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The Austral Otis Eng. Co., Ltd., So. Melbourne, Austr.
Morgardshammers Mek. Verkstads Aktiebolag, Mogardshammar, Sweden
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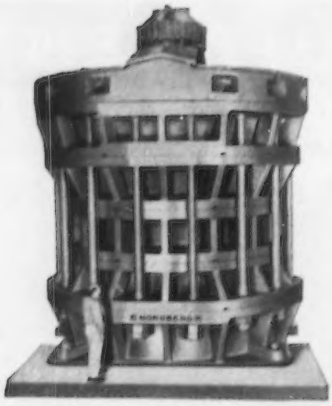
Sales Agents:
Andrews and George Co., Inc., 5 Shiba Park, Tokyo, Japan
Continental Sales and Equipment Co., Hibbing, Minnesota
Edw. J. Nell Co., Manila, P. I.

The Mine & Smelter Supply Co.

And Its Subsidiary Company

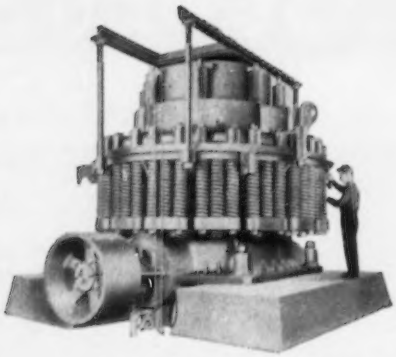
COLORADO IRON WORKS CO.

DENVER • SALT LAKE CITY • EL PASO • NEW YORK



SYMONS® PRIMARY GYRATORY CRUSHERS... Built in sizes from 30" to 72" feed openings to meet any desired production operation.

SYMONS CONE CRUSHERS... The machines that revolutionized crushing practice. Built in sizes from 22" to 7' diameter heads with a wide range of capacity.



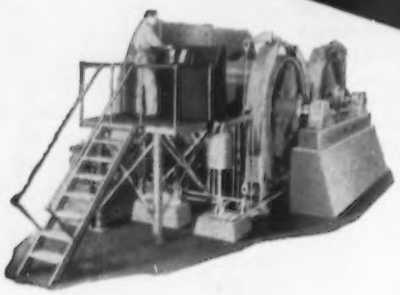
NORDBERG MACHINERY for the MINING INDUSTRY

For base metals...precious metals ...the rarer elements...non-metallics and minerals . . . NORDBERG MACHINERY is the outstanding choice of producers in the mining industry the world over.

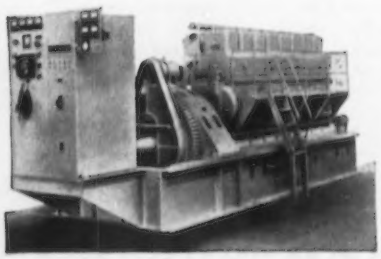
More than half a century of progressive engineering achievement, combined with quality production, in unexcelled manufacturing plants, have firmly established Nordberg's leading position in the field of heavy machinery design and construction.

Nordberg Machinery assures maximum and continuous production at low operating and maintenance cost. For full details, write for literature on the machinery you need.

NORDBERG MFG. CO.
Milwaukee, Wisconsin

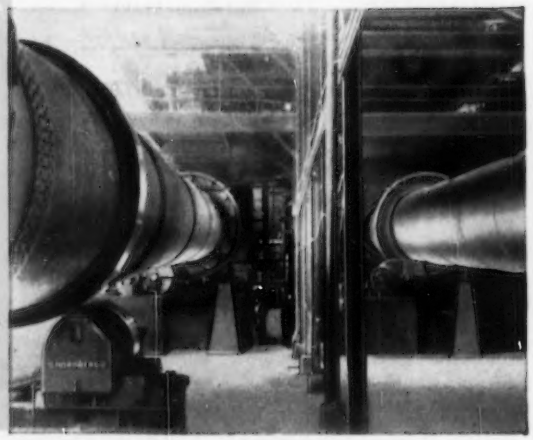


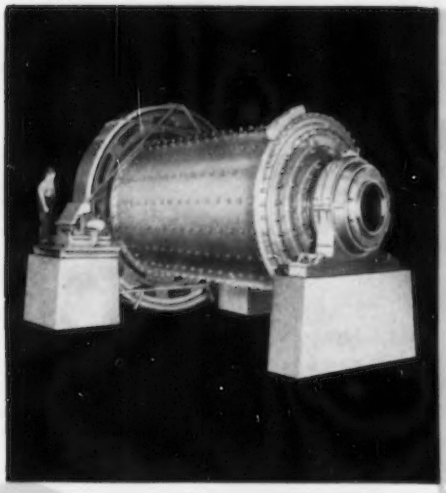
NORDBERG MINE HOISTS... As the source of the most progressive hoist engineering advances in the mining industry, Nordberg has held worldwide leadership in the hoist field since 1895.



NORDBERG ENGINES . . . For oil, gas or Duafuel® operation. Built in sizes from 10 to over 10,000 horsepower to meet practically all power requirements.

NORDBERG KILNS — DRYERS and COOLERS... To meet a wide range of requirements, including pyro processing operations, drying, calcining burning and cooling.



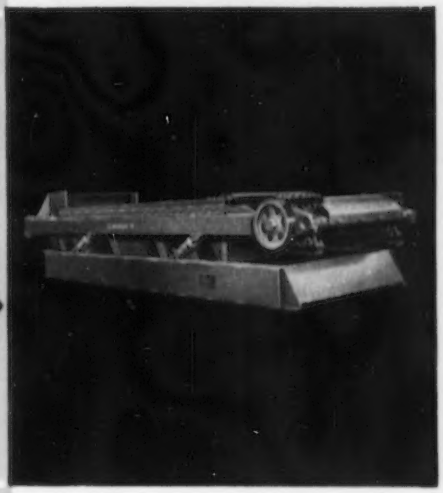


NORDBERG GRINDING MILLS . . . Ball, tube, rod and compartment types for wet or dry, open or closed circuit operation.

SYMONS VIBRATING GRIZZLIES . . . Built in bar and rod types for effective heavy duty scalping service handling feed sizes up to 30" and larger.

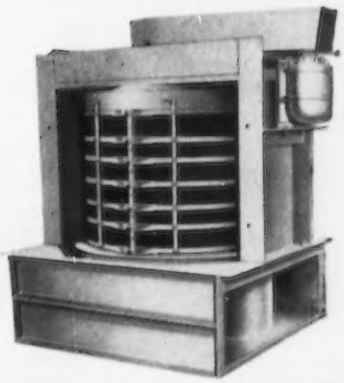
NORDBERG GYRADISC CRUSHER . . . A revolutionary machine for the production of large tonnages of extremely fine product.

SYMONS HORIZONTAL VIBRATING SCREENS . . . Level position assures extreme accuracy in sizing, requires less headroom, permits easy installation.



SYMONS ROD DECK SCREENS . . . Highly efficient screening surface of spring steel rods—easily replaced. Especially suited for wet, sticky materials.

SYMONS "V" SCREENS . . . For extremely fine, single cut wet or dry separations. Employs controlled diffused feed and vertical flow of material.



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M 155-R

NORDBERG MACHINERY

NORDBERG

CRUSHERS SYMONS SCREENS NORDBERG

MACHINERY FOR PROCESSING ORES and INDUSTRIAL MINERALS

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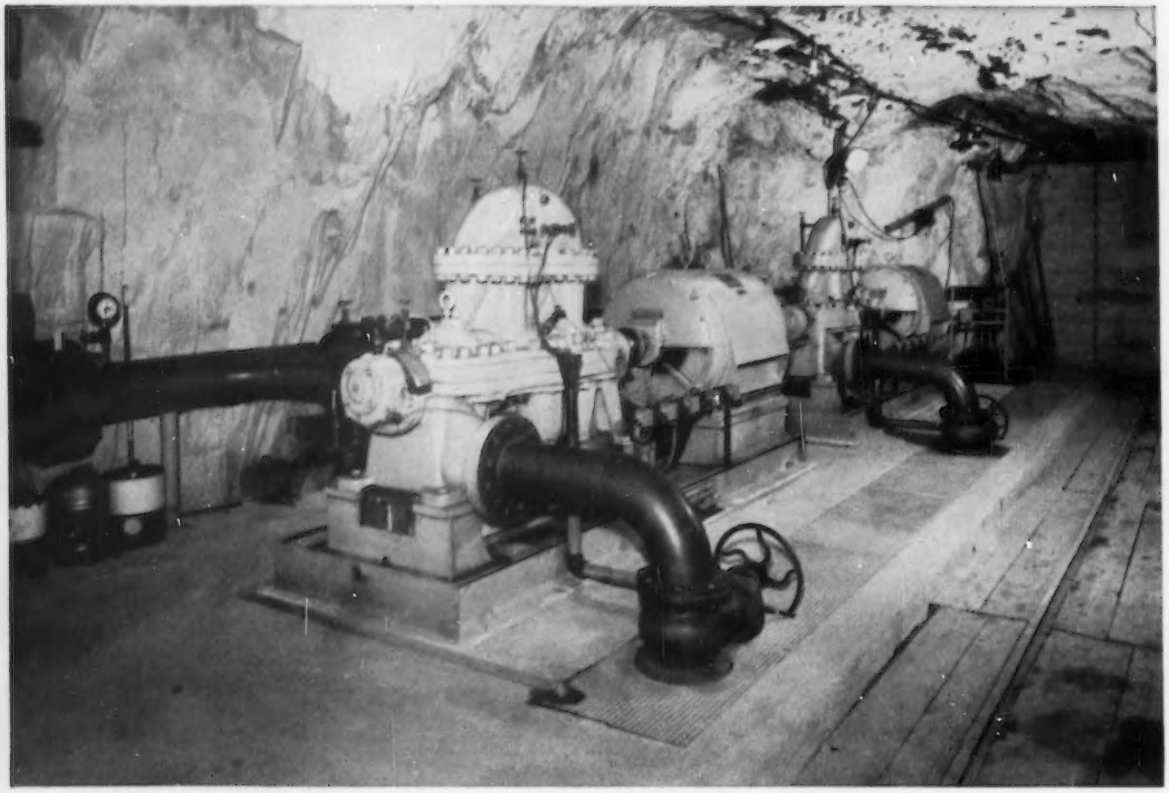
SYMONS . . .

A REGISTERED NORDBERG TRADEMARK KNOWN THROUGHOUT THE WORLD

Ingersoll-Rand Mine Pumps



Two 6-stage Ingersoll-Rand drainage pumps in the Star Mine at Burke, Idaho. Other I-R pumps in this mine include two 300 hp and two 250 hp multi-stage units, as well as numerous Motorpumps.

... meet exacting demands of drainage service at Star Mine of Bunker Hill Company, operated by Hecla Mining Co.

Installed on the 4000 ft. level of the Star Mine at Burke, Idaho, the two I-R pumps shown above boost water to the 2000 ft. or drainage level of the mine. Driven by 700 hp motors and rated at 1000 gpm each, 2050 ft. head, these units have been giving excellent service.

In the Coeur d'Alene mining area, in which the Star Mine is located, the traditionally fine performance of Ingersoll-Rand mine pumps has resulted in their selection for handling more than 95% of the mine water pumped. The exceptional service record of these units reflects Ingersoll-Rand's many years experience in the design, construction and application of pumps for mine drainage service.

Discuss your next pumping application with your nearby I-R representative. He is qualified to furnish complete information and recommendations.

Ingersoll-Rand

10-362 11 BROADWAY, NEW YORK 4, N. Y.

COMPRESSORS • GAS AND DIESEL ENGINES • ROCK DRILLS • PUMPS • TURBO-BLOWERS • AIR AND ELECTRIC TOOLS

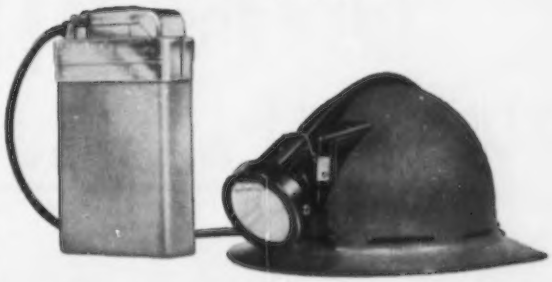
M.S.A. MINEPHONE

Messages are dispatched instantly to all motormen, who can receive and reply while trips are in motion. System keeps main line haulage-ways free of traffic tie-ups; reduces errors and accidents; prevents excessive stop-and-start strain on equipment.

M.S.A. HOISTPHONE

Continuous, clear voice communication between hoisting engineer and cage, at any level, and while cage is in motion. Ideal for safer load leveling, inspection trips, shaft repairs. Utilizes existing wiring. ALSO —M.S.A. PORTABLE HOISTPHONE—compact unit can be set up anywhere, put into immediate service. Permits temporary communication for inspection work, emergency jobs.

EDISON R-4 ELECTRIC CAP LAMP— M.S.A. TYPE K SKULLGARD



More and better illumination for today's modern mining methods. The R-4 Lamp's brilliant, unfailing illumination lets miners work faster, better, safer. The famous Type K Skullgard, is strong, light, durable. Maximum head protection that is not affected by oil, water, perspiration.

These M. S. A. products can help answer YOUR PRODUCTION-SAFETY NEEDS

M.S.A. SELF-RESCUER

For immediate breathing protection in emergencies. Vital to the miner while traveling through carbon monoxide to fresh air. Available in cache assemblies for storage throughout the mine, or in individual carrying cases. U.S. Bureau of Mines Approved.

M.S.A. CHEMOX

Provides complete breathing protection in any atmosphere. Chemox generates its own oxygen from replaceable chemical canister. Weighs only 13½ lbs. Comfortable in service. U.S. Bureau of Mines Approved.

M.S.A. DEMAND WORK MASK

Breathing protection for planned work in toxic atmospheres. Mask provides self-contained air or oxygen supply. Connecting hoses lets wearer move freely. Manifold arrangement permits use of more than one unit from a single cylinder.

M.S.A. DUSTFOE RESPIRATOR

Maximum protection against dusts. This unit is compact, very light in weight. Its design eliminates "blind-spots," provides wearing comfort that encourages full-time use. U.S. Bureau of Mines Approved.

M.S.A. CHEMKLOS

Made throughout of Dynel, the new fabric that resists acids and caustics, M.S.A. ChemKlos answer the need for longer-wearing, smarter-looking work clothes. Special weave for maximum resistance to abrasion. Also, miner's rubber suits, boots, etc.

M.S.A.-LAMB AIR MOVER

Practical, portable ventilating device that uses only compressed air or steam. No motors, turbines, fans. Three sizes—largest size moves as much as 5,160 cu. ft. air per min. Forces air in, or sucks fumes out.

M.S.A. RAIL PUNCH

Makes quick, safe work of punching holes through web sections without need of external power.

M.S.A. PNEOLATOR

Portable, self-contained automatic artificial respiration device. Unit is protected by rugged carrying case.

also—a complete line of portable instruments for detecting CO, H_2S, SO_2, HCN. Instruments for collecting, sampling, counting dusts. First aid kits and materials.

MSA
SAFETY EQUIPMENT HEADQUARTERS

When you have a safety problem, M.S.A. is at your service. Our job is to help you.

MINE SAFETY APPLIANCES COMPANY

201 North Braddock Avenue, Pittsburgh 8, Pa.

At Your Service: 77 Branch Offices in the United States and Mexico

MINE SAFETY APPLIANCES CO. OF CANADA, LTD.

Toronto, Montreal, Calgary, Edmonton, Winnipeg, Vancouver, Sydney, N. S.

It's the DIFFERENCE

You *Can't* See that Counts!

It's easy to distinguish Naylor pipe from other lightweight pipe by its familiar spiral. But what you can't see is the extra performance built into this lockseamed, spiral-welded pipe.

First, there's extra strength and safety, thanks to the spiral truss which acts as a continuous expansion joint to absorb shock loads, stresses and strains. Next, there's greater collapse strength that lets you use Naylor pipe in both vacuum and pressure service. In fact, this extra strength enables you to use lighter gauge material for economy on ventilating lines without sacrifice of performance. Also, the Naylor structure maintains true cylindrical form and holds its diameter accurately.

Once you use Naylor pipe for air lines, water lines, tailings lines or ventilating, you'll recognize what a difference this extra performance makes.

Write for Bulletin No. 507.

NAYLOR PIPE

NAYLOR PIPE COMPANY
1243 East 92nd Street
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Eastern U. S. and Foreign Sales Office:
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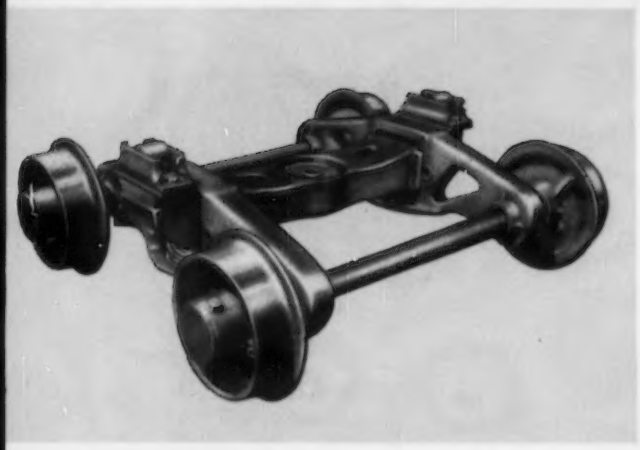
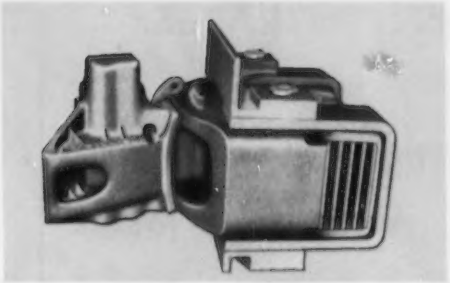
NATIONAL equipment cuts per-ton costs



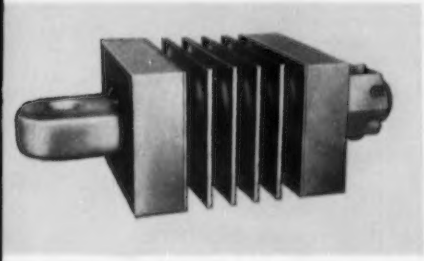
NC-1 MINE CAR TRUCK is the latest example of National's pioneering in better equipment. Among NC-1 truck advantages are longer and softer ride springs, friction damping mechanism that controls vertical and transverse oscillations, automatic frame alignment and cast one-piece bolster with large lubricated center bearing. A-9021

WILLISON AUTOMATIC COUPLERS save time with maximum safety, couple at either end of car or locomotive, require no manual assistance, eliminate damaging slack, permit high speeds with maximum stability.

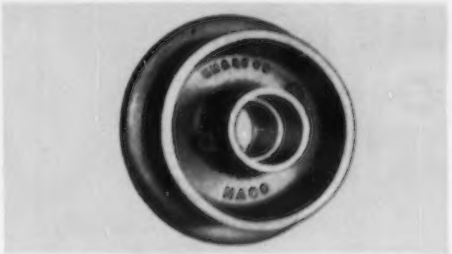


NATIONAL MI-235 Rubber-Cushioned Draft Gear primarily used in Willison spherical-horn coupler assemblies for drop-bottom cars and locomotives; are effective with link and pin bumpers and in strap yokes.

NATIONAL MI-225 Rubber-Cushioned Draft Gear for locomotives and large capacity cars not required to operate through rotary dump. Give maximum impact protection in minimum space.



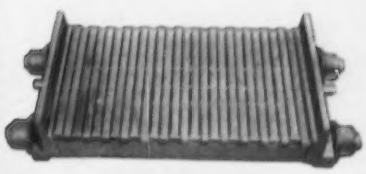
NATIONAL MI-230 Rubber-Cushioned Draft Gear for cars in rotary dump service. High-capacity rubber pads with soft initial action provide maximum impact protection, lengthen equipment life. Available in capacities and designs to fit individual requirements.



NACO STEEL WHEELS, made from quality-controlled Naco cast steel—of high yield point, great tensile strength and ductility—reduce tread spalling or flange breaking. Available in all sizes regularly used in mining or industrial operations.

NACO STEEL SWIVEL HITCHING AND LINK

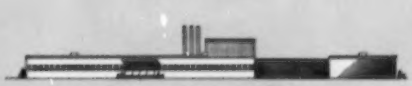
CAST ALLOY STEEL ORE-GRINDING BALLS



CAST STEEL PALLET AND MALLIX SINTERING BARS

NATIONAL MALLEABLE AND STEEL CASTINGS COMPANY • Cleveland 6, Ohio

Technical Center



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E. A. GODOY & CO., INC.

CUNARD BUILDING, 25 BROADWAY
NEW YORK 4, N. Y.

IMPORTERS

OF

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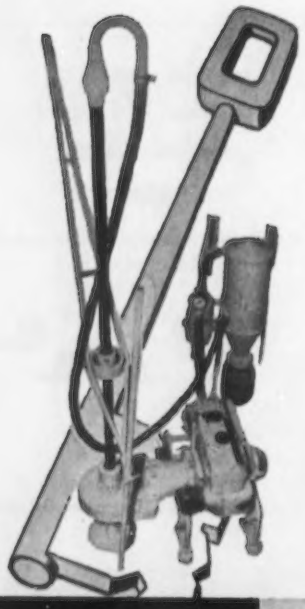
EXPORTERS OF

MACHINERY AND EQUIPMENT

FOR THE MINING INDUSTRY



THE KEY TO BETTER DRILLING

HI-VAC DRILLING SYSTEMS

DRILLS BY VACUUM
No Fuss - No Muss - No Dust

Impossible to lose circulation. Adaptable to geophysical, shot hole, blast hole, cat hole or surface pipe drilling rigs. Drills to 2000 feet. Removes cuttings at rate of 1 to 36 tons per hour.

MIGHTY MIDGET PORTABLE DRILL

- Weighs 125 lbs.
- Drills by vacuum — no water needed. 100% recovery of cuttings.
- Impossible to lose circulation. Powered by McCulloch 9 H.P. engine.
- Ideal for exploration drilling.
- Anywhere there is a hole to be drilled the Mighty Midget will drill it.
- For further information write Houston Tool Co., Santa Susana, California.

A PRODUCT OF THE HOUSTON TOOL CO.

THE OUTSTANDING MINE VENTILATION LINE

Outstanding

- ✓ FOR QUALITY
- ✓ FOR DEPENDABILITY
- ✓ FOR COMPLETENESS

ABC BRATTICE CLOTH

7 types to fit all needs —3 types of jute cloth, 2 types of cotton, plastic and Black Ace for nongaseous mines. Carefully processed to resist flame, except Black Ace, and to resist mildew. In widths and lengths for any seam.

MineVent

FLEXIBLE VENTILATION TUBING

Made in two grades: jute base and cotton base, synthetic rubber coated. Resists leakage, abrasion and moisture. Available in 9 diameters, 8" to 36" and 25, 50 or 100 ft. lengths. Choice of 3 types of suspension, demountable patented Snap-On coupling or Sewed-In coupling. Most widely used mine ventilation tubing.

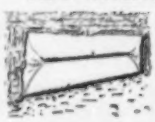
NEOLON FLEXIBLE VENTILATION TUBING

The new Neoprene coated Nylon fabric tubing. Almost impossible to tear. Airtight. Resistant to abrasion, acid mine water and flexing. Same lengths and diameters as MineVent.

NON-COLLAPSIBLE TUBING

Both MineVent and Neolon are available with telescoping spring wire inserts rendering the tubing non-collapsible. Light weight. Economical.

ABC INFLATABLE BRATTICE



Sizes to fit any opening. Readily fills rough contours, jagged walls, etc. Quickly inflated by special hand pump. Quickly deflated to move to new location. Easy to transport. Economical to use.

ABC POWDER BAGS

Rubber coated durable fabric, firmly sewed, for long use and hard wear. 5 sizes: 20, 30, 60, 125 and 160 sticks of explosive.

Sent for Catalog 55.

ABC AMERICAN BRATTICE CLOTH CORP.
WARSAW, INDIANA

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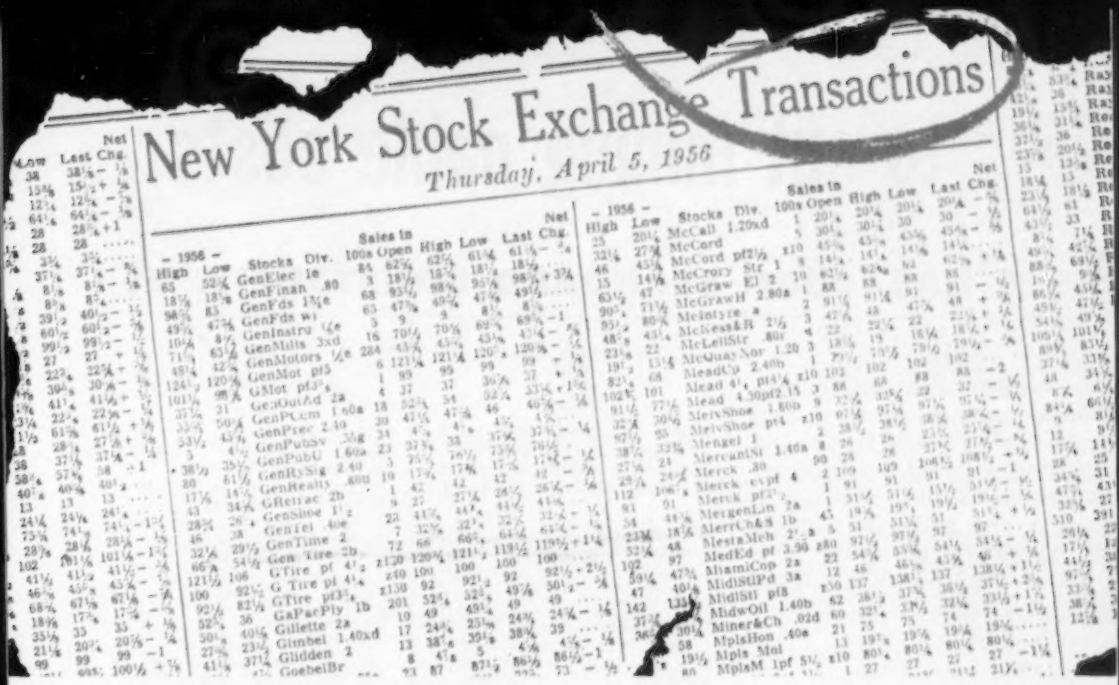

New York Stock Exchange Transactions

Thursday, April 5, 1956

– 1956 – High	Low	Stocks	Div.	Sales in 100s	Open	High	Low	Last	Net Chg.
65	52¼	GenElec	1e	84	62⅝	63⅝	61¼	61⅛	– ¼
18⅝	18⅛	GenFinan	.80	3	18½	18⅝	18¼	18½	
83		GenFds	1⅓e	65	47⅝	49⅝	47⅛	49½	+ 3/8
47⅜		GenFds wi		5	9	9	8½	8⅝	
8½		Geninstru	1/4e	16	70½	70⅝	69⅜	69⅜	– 1
65½		GenMills	2xd	284	43⅝	43⅝	43⅛	43¼	– ⅛
42⅜		GenMotors	1/4e		121¼	121¼	120⅞	120⅞	– ⅛
120⅝		GenMot	pf5	6	121¼	99	99	99	
98⅜		GMot	pf3⅓	1	99	37	37	37	+ ⅛
31		GenOutAd	2a	4	37	34	32¾	33⅛	+ 1⅛
50¾		GenPict	2.40	18	52⅜	47⅜	46	46⅝	– ⅛
43⅞		GenPrec	1.60a	20	47⅛	47⅛	45	45	– ¼
55		GenPubSv	.35g	34	47⅛	38	37⅝	37½	– ⅛
4½		GenPubU	1.60a	23	37⅜	37⅜	36½	36½	– ⅛
35½		GenRyStg	2.40	3	35½	36½	36½	36½	
61½		GenRealty	.40g	10	17⅜	17⅜	17⅛	17⅛	– ⅛
14⅝		GRefrac	2b	1	42	42	42	42	– ⅛
34⅜		GenSnow	1½	9	27	27¼	26½	26¾	– ⅛
26¼		GenTel	.40e	22	44⅛	44⅛	44⅛	44⅛	
38		GenTime	2	7	32⅜	32⅞	32⅛	32⅛	– ⅛
29½		Gen Time	2b	72	66	66⅝	64¼	64¼	– ⅛
54½		Gen Tire	2b	z120	120¾	121½	119½	119½	+ 1¼
106		GTire pf	4½	z10	100	100	100	100	
92½		G Tire pf	4¼	z130	92	92½	92	92½	+ 2½
82¼		GTire pf	3¾	201	52¾	52¾	49¼	49	– ⅛
36		GaPacPly	1b	10	49	49¼	49	49	
40½		Gillette	2a	17	24¼	25⅛	24⅜	24⅜	– ⅛
23½		Gimbel	1.40xd	13	38⅛	39⅛	38¾	39	
37½		Glidden	2	8	47⅛	5	47⅛	43⅝	– ⅛
		GoebelBr		93	87	87½	86½	86½	– ½
		Goodall	1.20	1	20¼	20¼	20¼	20¼	– ⅛
		McCall	1.20xd	5	30¼	30¼	30	30	– ⅛
		McCord		5	45⅜	45⅜	43⅝	43⅝	– ⅛
		McCord	pf2½	z10	45⅝	45⅝	14⅛	14⅛	
		McCrory	Str 1	8	14⅛	14⅛	14⅛	14⅛	+ ⅛
		McGraw	El 2	10	62½	62⅝	62⅜	62⅜	
		McGrawH	2.80a	1	88	88	88	88	– ½
		McIntyre	a	2	91½	91¼	91	91	– ½
		McKesn&R	2½	3	47¼	48	47¾	48	+ ⅛
		McLeanTr	.80r	4	22	22	22	22	+ ⅛
		McLellStr	.80r	3	18⅜	19	18⅛	18⅛	+ ⅛
		McQuayNor	1.20	3	73½	73½	73½	73½	– ⅛
		MeadCp	2.40b	1	71½	102	102	102	
		Mead	4¼ pf	z10	102	88	88	88	– 2
		Mead	4.50pf2	3	88	88	88	88	
		Mead	4.50pf2.15	3	88	88	88	88	
		MeadJohn	1.80b	9	32¼	32⅝	32	32	– ½
		MelvShoe	1.80b	9	32¼	32⅝	32	32	– ½
		MelvShoe	pf4	z10	97¼	97¾	97¾	97¾	– ⅛
		Mengel	1	2	38½	38½	38⅜	38⅜	– ⅛
		MercantSt	1.40a	8	26	26	26	26	
		Merck	.80	90	28	28	27½	27½	+ ⅛
		Merck	pf4	2	109	109	108½	108¼	– 1
		Merck	pf3½	1	91	91	91	91	
		MergenLin	2a	1	31½	31½	31½	31½	– ⅛
		MerrCh&S	1b	45	19⅝	19⅝	19½	19½	+ ⅛
		Mesta&Meh	2½a	5	51	51	51½	51½	
		MedEd	pf 3.90	z80	97½	97½	97	97	– ⅛
		MiamiCop	2a	22	54⅞	55¼	54½	54½	– ⅛
		MidlSUPd	3a	12	46	46⅜	43⅝	46	+ 1½
		MidlStlPf	pf8	z50	137	138½	137	138½	+ 2½
		MidwOil	1.40b	82	38½	37¾	36½	37½	+ 1½
		Miner&Ch	.02d	60	32¼	33¼	32¾	33½	+ 1⅛
		MplsHon	.40e	21	75	75	74	74	– 1½
		Mpls Mol		13	19⅞	19⅝	19⅝	19⅝	
		MplsM	1pf 5½	z10	80¼	80¼	80½	80½	
				1	27	27	27	27	– 1¼

GENERAL REFRACTORIES

NONE...without brick!

That's right—NONE! No sales . . . no profits . . . no financial page . . . no industry. *You* would have nothing to make . . . buy . . . sell . . . or transport were it not for refractory brick.

Because everything made . . . everything that moves owes its very existence to refractories.

Refractories, you see, are born in many shapes and of many compositions to do a variety of jobs. It's brick and high-temperature refractory mortars, plastics, castables, and bulk products that prison temperatures of thousands of degrees for industry.

General Refractories, making and distributing exactly the right refractory to industries everywhere, maintains the world's largest refractories laboratory and draws resources from all over the globe.

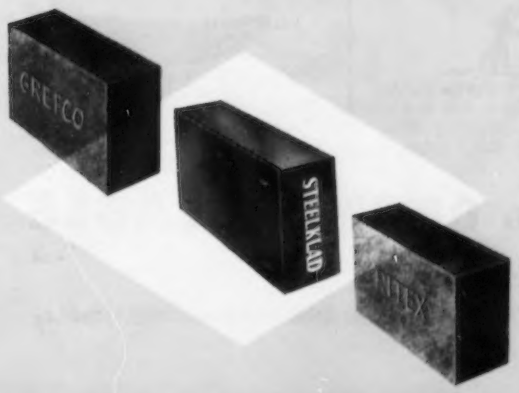
A Complete Refractories Service

GENERAL REFRACTORIES COMPANY

Philadelphia 2

A COMPLETE REFRACTORIES SERVICE FOR THE COPPER INDUSTRY

Three types of basic brick—RITEX, GREFCO, STEELKLAD for the three basic processes—smelting, converting and refining. Each type of brick available in the ranges of composition—Magnesite, Magnesite-Chrome, Chrome-Magnesite and Chrome—required to adapt to variations in metallurgical processing.



RITEX—chemically bonded for low cost, superior workmanship, resistance to spalling, ready availability.

GREFCO—conventional type bonded by tunnel kiln high temperature firing, for maximum strength and hardness.

STEELKLAD—steel encased on two, three or four sides and for special jobs, steel plates incorporated in the brick interior as well—for maximum resistance to spalling in the most severely treated exposed walls.

RITEX, GREFCO and STEELKLAD—each the result of many years of intimate knowledge of the copper industry and careful study of service conditions, each prepared from the best available raw materials and made with the most modern manufacturing facilities—all within easy access to your operation.

3 ways to cut mining cable costs...

1. USE HAZACORD STANDARD CONSTRUCTIONS

Each Hazacord construction has been designed to cut cable replacements on specific mining machines. Standard constructions for most of the important services are built from the conductor out to insure long life in the face of continual high speed reeling, rock-falls, frequent run-overs and constant dragging over mine floors and around corners. Here are four Hazacord standard constructions.

Single Conductor—Reel cable made extra flexible and tough, Hex-Tite assembly to withstand re-reeling, rubbing and scraping.

Two-Conductor Round, Type G—Cable with two ground wires and two insulated conductors possesses maximum flexibility.

Three-Conductor Type W—Cable with three insulated conductors is available with heat-resistant insulations for either low or high voltages.

Twin Type G—Cable designed for maximum safety and reel capacity has center grounding wire and two insulated conductors.

2. USE OKONITE SPECIAL CONSTRUCTIONS

When you need a cable with unique specifications, consult with Okonite and avoid the costly troubles that often result from makeshift solutions. Special constructions are available for the newest mining equipment, including all types of continuous miners. Here are examples of the many Hazacord special constructions that are manufactured to the same rigid specifications as standard constructions.

Three Conductor-Type PG—Special cable for d-c systems has uninsulated grounding wire which is approximately half the size of the two insulated conductors.

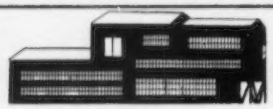
Four-Conductor Type PG—Special cable for d-c systems is similar to three-conductor type except with 3 insulated conductors.

Five-Conductor Type PCG—Special cable for "permissible" equipment features 1 uninsulated grounding, 2 insulated control and 2 insulated power conductors.

Six-Conductor Type PCG—Special cable for a-c systems is similar to five-conductor type except with 3 insulated conductors.

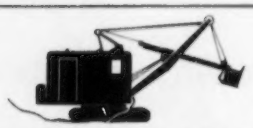
3. CONSULT WITH OKONITE ENGINEERS

The Okonite engineering staff is always ready to help you in the planning stage. Plant or mine power distribution, borehole or shaft cables, control systems, telephone circuits, conveyor controls . . . whatever your needs, Okonite will gladly help you select the safest and most economical cable for the job. Write or phone either our nearest district office or The Okonite Company, Dept. EMG, Passaic, N. J.



. . . Watertite-Hazaprene Wire, Keystone-Hazaprene Wire, Hazacord Flexible Cords, Watertite-Hazaprene Control Cable, Aerial Cable, Hazaprene Line Wire . . .

. . . . Hazacord Portable Cables Types W, G, SH-A, SH-B, SH-C, SH-D . . . Blasting Wire, Redshot Type RG, Type D Braided . . .



. . . Hazacord Mine Drill and Control Cord, Hazacord Type SO, Parkway, Okonite Mine Power Cable, Hazacord Twin Type W . . .

. . . Continuous Mining Cable, Hazacord Two-, Three-, Four-, Five-, and Six-Conductor Types G, W, PG, and PCG . . . Steel Armored, Self-Supporting . . .

where there's electrical power . . . there's **OKONITE CABLE**

4184

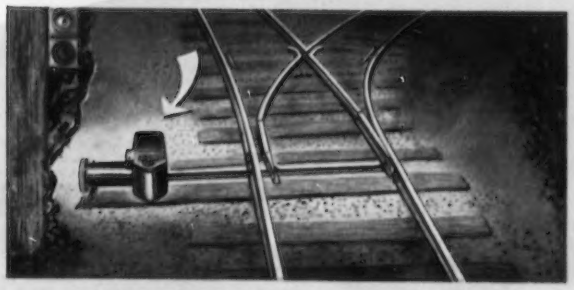
Magic Performance

PILES UP SAVINGS...

When you are expected to pull profits out of your hat, just turn to American Mine Door profit-making equipment.

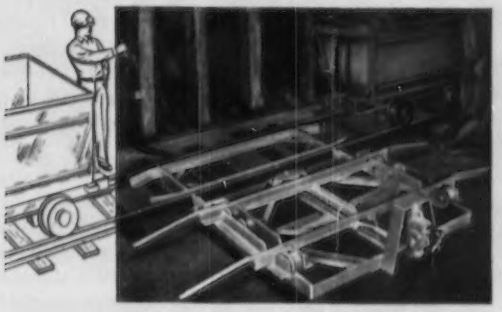
"CANTON" TRACK CLEANERS

Model 20 designed for low coal . . . Model 40 for the average mine. Keep road beds clean, saving thousands of dollars per month. Now rendering spectacular performance in coal, iron, copper, potash and salt mines . . . tailor-made to your specifications.



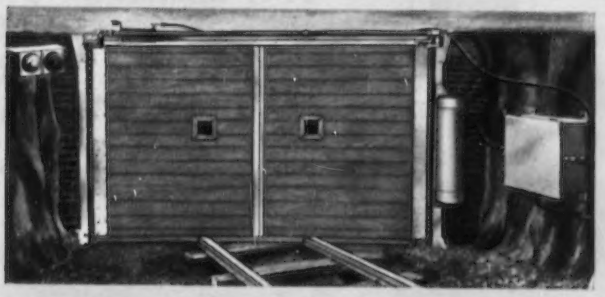
"CANTON" DEPENDABLE SWITCH THROWER

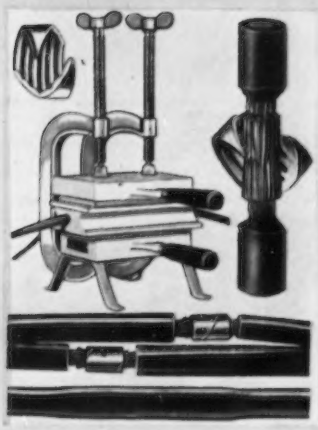
Make extra profits with extra speed. No jumping on and off trips . . . man hours, man lives saved . . . more tons taken out . . . greater profits per shift. Reliable "American Mine Door" mechanism.



"CANTON" AIR POWER CAR TRANSFER

New Air Power is added to the money-saving Car Transfer. One man does the work of three. Loads entire train on a single track. Less rib to shoot than for jump switch . . . no hazards of cherry picker. Air Power now 50% faster. Can be installed on your present hand model.





"CANTON" CABLE SPLICER AND VULCANIZER

"Canton" Cable Splicers are greatest reducer of down time. Every machine man should carry a pocketfull. Just pound around cable and go on working. No special tools. Used with vulcanizer in shop makes new, smooth, snagless splice strong as original cable.

"CANTON" MECHANICALLY OPERATED DOORS

First, the "Canton" mechanical door, not subject to power failures, famous for half a century . . . NOW the "Canton" Air Power Door with overhead operating equipment, BOTH effect tremendous savings by allowing full speed, profitable trips, eliminating accident potential of hand doors.

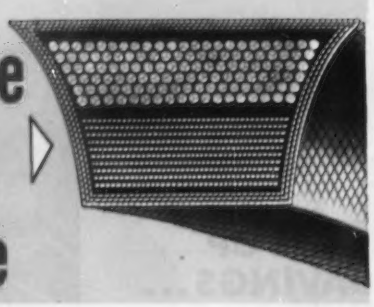
Half Century of Dependable Service

THE AMERICAN MINE DOOR CO.

2039 Dueber Ave., Canton 6, Ohio

We'll install "Canton" American Mine Door Products in your mine. Pay us out of increased profits. Write for complete brochures. Please use street and zone numbers.

Why this curve lengthens V-belt life



THE CONCAVE SIDES (U.S. Patent 1813698) of every Gates V-Belt are a precisely engineered curve. This curve greatly lengthens V-belt life for this interesting reason:

When you bend a Gates V-Belt, just as it is bent around a sheave, the concave sides (Fig. 1) become straight. Therefore, the belt makes full contact with the sheave, gripping the sides evenly (Fig. 1-A) and wear is distributed uniformly across the sidewalls of the belt. Naturally, uniform wear lengthens belt life; saves on replacement costs and cuts down-time.

Now see what happens when you bend a straight-sided belt. (Fig. 2) Just feel the sidewalls *bulge out* at the bend. The bulge causes *uneven* contact with the pulley, as in Fig. 2-A. And uneven contact causes excessive wear at points shown by arrows; belt life is shortened.

Cut costs by getting longer wear from your V-belt drives. Specify Gates Vulco Rope—the V-belt with concave sides. Your nearby Gates distributor will supply your needs promptly. The Gates Rubber Co.—*World's Largest Maker of V-belts.*

There are Gates Engineering Offices and Distributor Stocks in all industrial centers of the United States and Canada, and in 70 other countries throughout the world.

TPA-74

Gates VULCO ROPE Drives

HAMMOND'S SAFE BLASTING EQUIPMENT

EXPLOSIVE BOXES

These rigid non-conductive explosive boxes represent a prime safety investment. Made entirely of wood-tongue-grooved and dovetailed construction . . . no metal parts . . . automatic lock . . . rubber band spring . . . moisture-resistant. Box sizes are based on 1¼ x 8" sticks.

WOOD TAMPING POLES

For Tamping Explosive Shots: Poles are round, made of Hardwood. Sizes to 10' long.

SECTIONAL TAMPING POLES

These poles are made of straight grained wood and are coupled together with removable wood pins held in place in recessed grooves by a rubber band and can be quickly connected and unconnected. Couplers and Head Blocks are 4, 5, and 6 inches in diameter. Please specify size when ordering. Poles are 1½" in diameter.

J. V. HAMMOND CO.

Spangler, Pa.—Catalog on Request

EAGLE WASHERS & CLASSIFIERS

FOR ORE AND NON-METALLIC MINERALS

- Single and double screw fine material washer-classifier-dehydrators with Ribbon type screws, up to 48" diameter, with replaceable Ni-Hard shoes.
- Eagle Water Scalping-classifying Tanks featuring automatic control valves.
- Heavy duty Log Washers, with logs up to 48" diameter. Sturdy tubular log shaft.

Ask about minerals now being processed by Eagles.

Send for Catalog 55.

EXPERIENCE. PROGRESS. SERVICE. SINCE 1872

EAGLE IRON WORKS

282 HOLCOMB AVE., DES MOINES, IOWA

FINE MATERIAL WASHERS

LOG WASHERS

"SWINTER" DREDGE LADDERS

BREAKER BALLS & PILE HAMMERS

DART 205-UG 20-ton end dump shuttle truck. Note driver's swivel seat and dual controls for forward or reverse travel. In reverse, driver sights through porthole in canopy.

OIL from ROCKS VIA 4 DART TRUCKS

For use in its experimental shale oil plant at Rifle, Colorado, the U. S. Bureau of Mines recently put to work four custom-built DART Trucks. The shale mines are underground and the trucks are specially designed to negotiate sharp corners and close quarters. The trucks are driven into the mine backwards and after loading, driven out in forward gear. Then there's a long road-haul to the processing plant. Unusual performance is required. The trucks are powered by 225 HP Diesel engines with Twin-Disc Torque Converters and Fuller 4-speed transmissions. The rock-type body, with removable cab protector, has a capacity of 15 cubic yards.

172,400 pounds of DART Trucks lined up to carry more than 80 tons of oil-bearing shale. With a wheelbase of 126", the trucks turn in a radius of 28'.

Ease of handling the big trucks is a boon to the operators. Hydraulic steering, air brakes and dual controls for shuttling eases the job, adds safety.

Up goes 20 tons! Twin 7½" diameter double acting, two-stage Hydreco hydraulic hoists provide fast and positive dumping.

DART TONNAGE ENGINEERED TRUCKS

Kansas City 8, Missouri

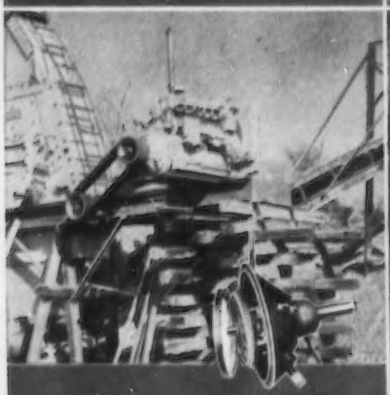
D-116

SUBSIDIARY OF THE CARLISLE CORPORATION

CRAWLER TORQUE CONVERTER

FLUID POWER TAKE-OFF

TRUCK-TYPE TORQUE CONVERTER



FRICTION POWER TAKE-OFF

FLUID COUPLING

CL FRICTION CLUTCH

Wherever you find ORE... you also will find TWIN DISC

In mining—wherever power is applied to driven equipment—you're likely to find Twin Disc Friction Clutches or Fluid Drives.

In removing overburden, you'll find the biggest crawler tractors driving through Twin Disc Torque Converters . . . power shovels, equipped with either Twin Disc Converters or Fluid Power Take-Offs . . . and trucks incorporating Twin Disc Truck-Type Torque Converters.

In removing and processing ore, you'll find stationary power units equipped with rugged Twin Disc Friction Power Take-Offs . . . conveyor systems, receiving a *shock-cushioning* flow of power through Twin Disc Fluid Couplings . . . and drills, equipped with Twin Disc Model CL or EH Friction Clutches.

Today, Twin Disc is the world's largest exclusive manufacturer of a complete line of friction and fluid drives—for correctly linking horsepower to industrial powered equipment. Since 1918, Twin Disc *specialists* have designed and built friction and fluid drives *for that one purpose.*

If *you* have a power transmission headache—consult the Twin Disc Clutch Company, Racine, Wis., Hydraulic Division, Rockford, Ill.

TWIN DISC

TWIN DISC

Friction Clutches and Fluid Drives

TWIN DISC CLUTCH COMPANY, *Export Division*, ROCKFORD, ILLINOIS, U.S.A.

PACKAGED MINE HOISTS

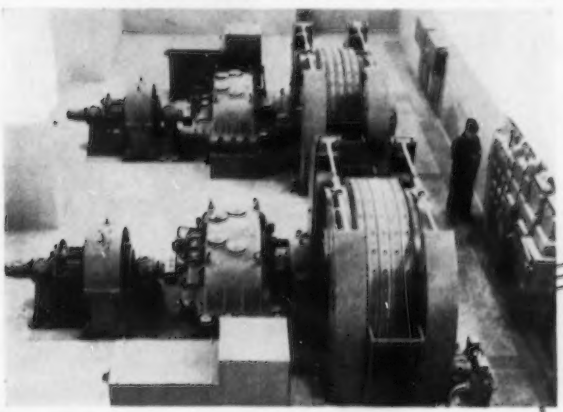
COMBINE
all mechanical and electrical equipment into one, complete, factory-assembled and guaranteed hoisting plant package.

COMBINE unique *safety* of operation, due to load-dividing parallel ropes, positive protection against damage from over-winds, and patented electric speed guards with *flexibility* through fingertip "switch-over" choice between fully automatic, push-button, or manual control for hoisting from any one of a number of levels.

COMBINE hoisting *capacity* up to the largest yet to be installed in any mine with *small space requirements*—small enough to allow hoists to be installed in headframes.

COMBINE *saving in first costs* of hoisting equipment, foundations, lifting facilities, hoist housings and headframes with *reduction in operational costs* due to less rope wear, lower power demand, fewer or no operators and less maintenance.

These two ASEA mine hoists with four parallel ropes are among those mounted above the shaft



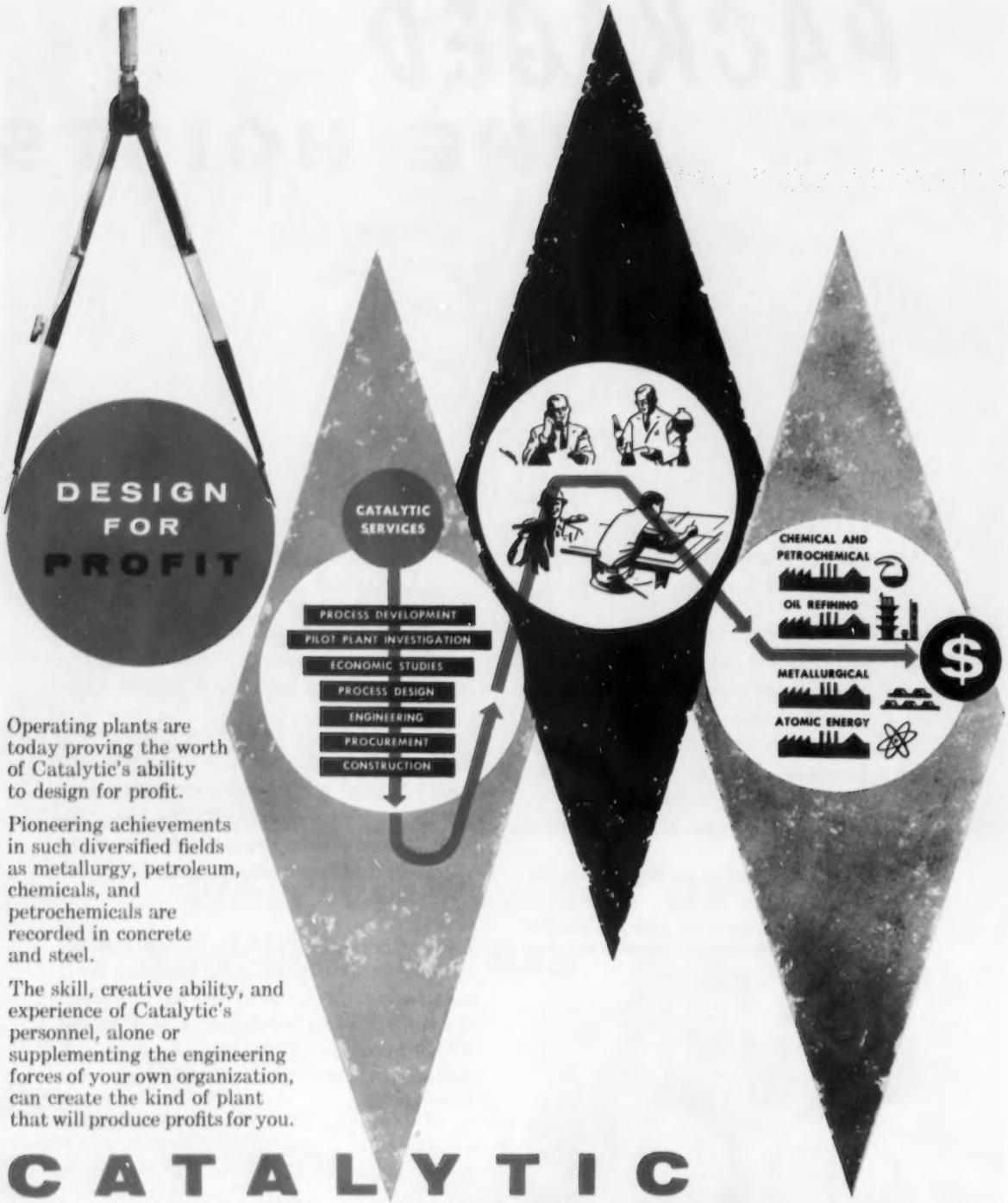
Take advantage of ASEA's 20 years of experience in developing these complete hoist installations. Let us send you our introductory bulletin with more information about the ASEA hoists, or if you have any plans for new hoisting facilities let us talk them over with you.

AROS ELECTRIC, INC.
16 EAST 71ST STREET
NEW YORK 21, N. Y.

COUPON

AROS ELECTRIC, INC.
16 East 71 Street, New York 21, N. Y.
Please send me your free introductory bulletin on the ASEA multi-rope mine hoists.

Name_____
Company_____
Address_____ State_____
City_____



Operating plants are today proving the worth of Catalytic's ability to design for profit.

Pioneering achievements in such diversified fields as metallurgy, petroleum, chemicals, and petrochemicals are recorded in concrete and steel.

The skill, creative ability, and experience of Catalytic's personnel, alone or supplementing the engineering forces of your own organization, can create the kind of plant that will produce profits for you.

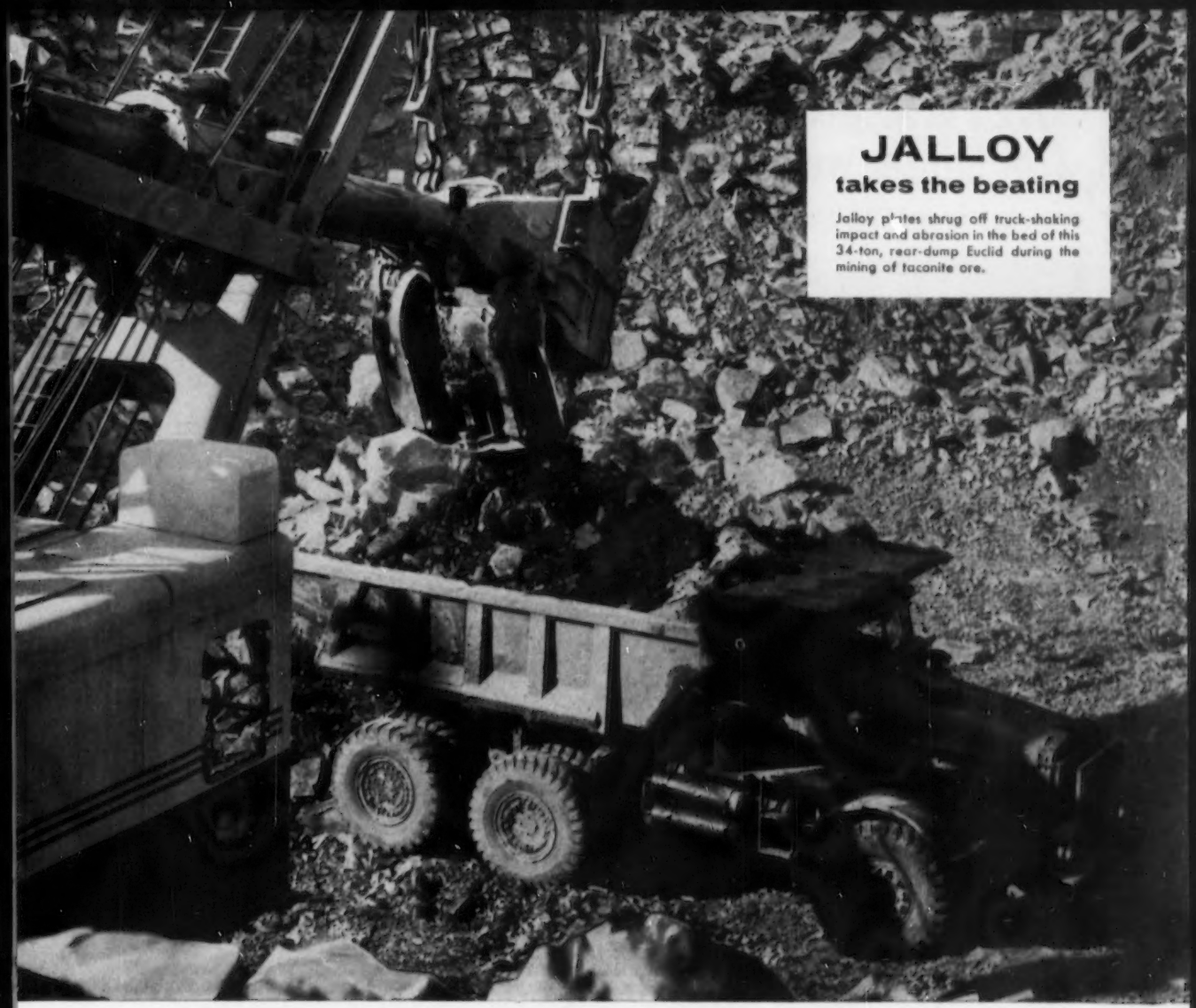
CATALYTIC

CONSTRUCTION COMPANY

PHILADELPHIA 2, PENNSYLVANIA • TOLEDO, OHIO

In Canada:
CATALYTIC CONSTRUCTION OF CANADA, LIMITED; SARNIA, ONTARIO; MONTREAL, QUEBEC

CATALYTIC *ON-TIME*... *ON-BUDGET* SERVICES
for the metallurgical, chemical, petrochemical and oil refining industries: Project Analysis; Process Development; Process Design; Economic Studies; Engineering; Procurement; Construction; Plant Operation



JALLOY
takes the beating

Jalloy plates shrug off truck-shaking impact and abrasion in the bed of this 34-ton, rear-dump Euclid during the mining of taconite ore.

Jalloy heat treated steels . . .

cut maintenance—give longer wear life

Jalloy—special purpose steels that are heat treated to provide longer wear on applications where impact and abrasive conditions are severe—last 4 to 20 times longer than conventional mild steels. Furthermore, they are easily welded.

Jalloy is available in three grades:

No. 1—for applications requiring excellent formability or where a low carbon alloy steel possessing good physical properties before or after heat treatment is specified. This is an ideal carbonizing grade.

No. 3—a general purpose steel capable of being heat-treated to excellent physical properties. Compared to ordinary mild steels it offers good resistance to abrasion or wear in the as-rolled state; but when heat treated to Brinell 340 and above, optimum abrasion and impact resistance is secured.

No. 7—possesses high hardness together with good ductility or wear resistance. Excellent for spring applications as well as flat work.

Jalloy high strength steels are available as plates, structurals, bar and small shape sections, hot rolled sheets, as well as strip and wire products.

* * *

Complete data concerning *Chemical Composition . . . Heat Treatment . . . Weldability . . . Physical Properties . . .* will be mailed to you promptly. Write today for your copy.

Jones & Laughlin
STEEL CORPORATION · PITTSBURGH

J&L STEEL

JALTEN gives equal strength
with lighter weight. Jalten steel plates go well with a weld.
Pre-heating is unnecessary with Jalten—even the weld is a factor in fatigue resistance

Low alloy, high strength Jalten offers good formability coupled with excellent corrosion and abrasion resistance

Jalten's high strength permits high design loads. It also permits a reduction in section when used to replace mild steels. Usually the reduction amounts to two gages affording a weight savings of approximately 25 per cent. Thus, dead weight can be eliminated—resulting in increased carrying capacity. Also, it is easily welded.

Jalten is furnished in four grades:

No. 1—possesses high strength, good formability and fabricating qualities—good resistance to low temperature impact.

No. 2—offers high strength, moderate formability—improved resistance to atmospheric corrosion.

No. 3—gives high strength—improved resistance to abrasion.

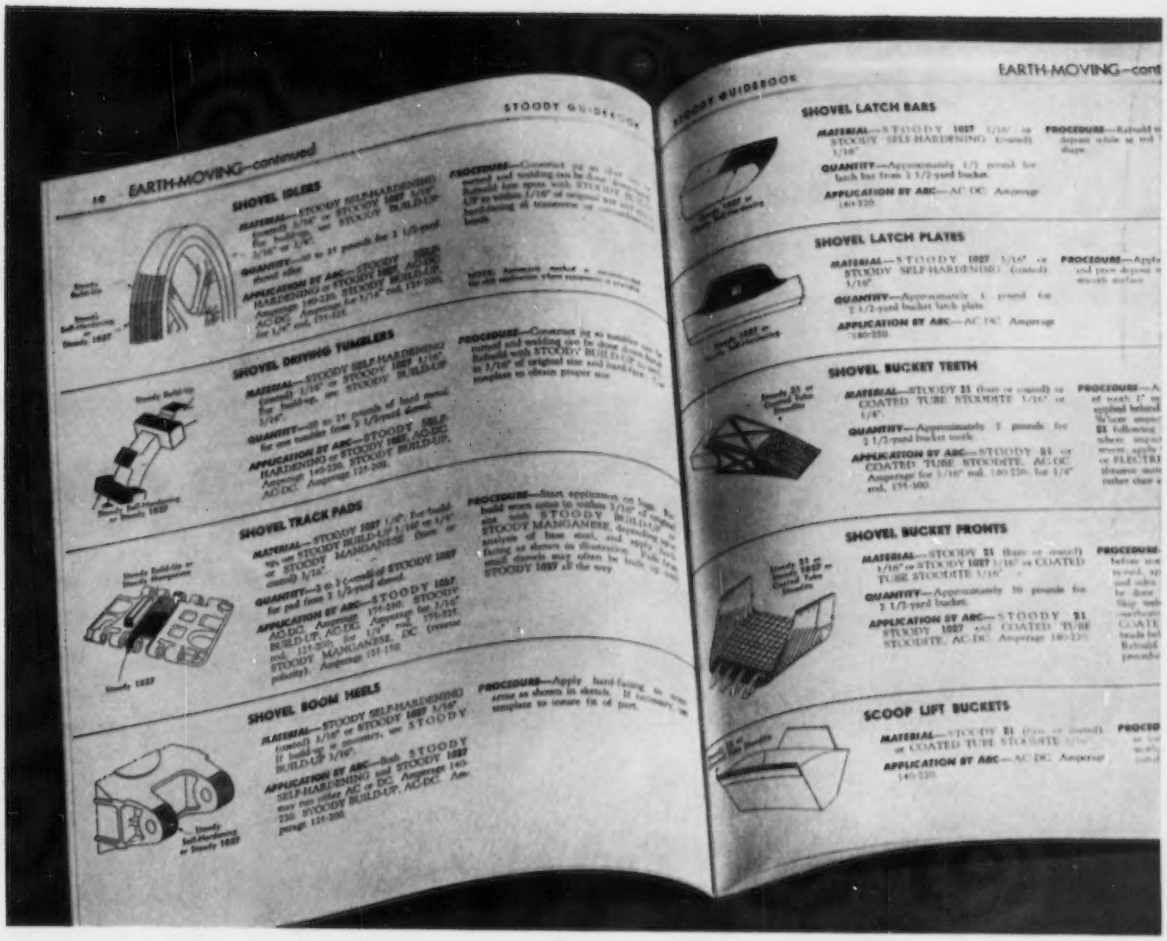
No. 4—provides superior formability and surface quality for bumper stock applications requiring plating.

Jalten Steels are available as sheets, strip, plates, structurals, bars and small shape sections.

SEND FOR THIS NEW BOOK:
Chemical properties of Jalten
Mechanical properties of Jalten
Jalten equivalents
Jalten application data

Jones & Laughlin
STEEL CORPORATION · PITTSBURGH

J&L STEEL



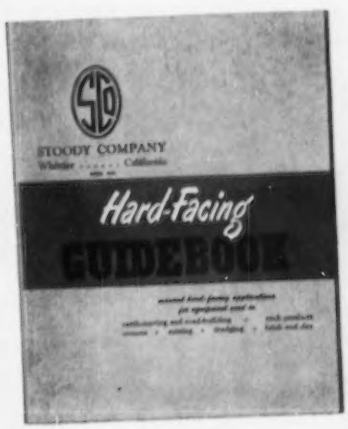
The BOOK OF HARD-FACING KNOWLEDGE

Contains the results of 30 years' hard-facing experience!

It's a well known fact that almost any hard-facing makes equipment last longer... but thoughtful users should ask themselves, *"at what price?"*

Hard-facing is of value when it effects a distinct economy...*when it costs you considerably less than the price of a replacement, when it makes worthwhile improvements in production or greatly reduces normal maintenance costs.* How, then, can *you* tell which hard-facing material will prove most economical without actually making the investment?

Here's your safest answer... follow the recommendations of your Stoody Hard-Facing Guidebook. This is a 30 year summary of successful hard-facing procedures on all types of equipment, under all kinds of conditions, in actual field operations!



Stoody's vast store of hard-facing knowledge is based on first-hand experiment and intensive testing. Each procedure has withstood the test of time. It is doubtful if this direct development of hard-facing applications can be duplicated by any other hard-facing manufacturer. Yet this knowledge is yours for the asking. And it will prove to be your best assurance of maximum performance for every hard-facing dollar invested. Write for your copy of the GUIDEBOOK today!

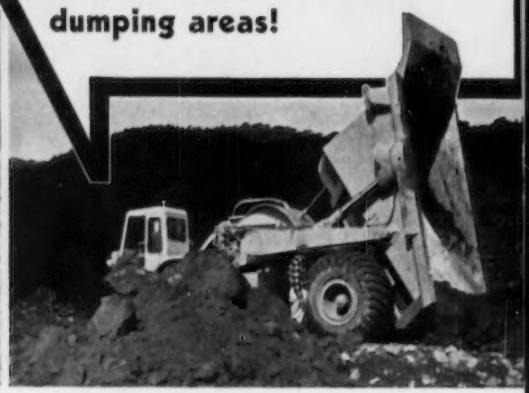
STOODY COMPANY
11940 East Slauson Avenue
Whittier, California

Cash-In on Tractor-Trailer

...with the *Athey* Trailer

REAR DUMP

for more maneuverability in restricted loading and dumping areas!



Fast, Clean Dumping — Positive, compact, efficient, hydraulic system lifts the body and dumps any load quickly and cleanly. Here's fast dumping in tight places where "rigid frame" units cannot maneuver!

With Cat-Athey Tractor-Trailer unit, you're flexible to meet the needs of your job. There are none of the limitations of a "rigid frame" unit. Thus, you can save time and money in loading, hauling and dumping. Above, for example, the Athey PR21 Rear Dump Trailer has unexcelled maneuverability in pioneering work, narrow benches and close quarters. No awkward backing into narrow loading or dump areas to slow up the job.

With the articulated, "universal-joint" design of the tractor-trailer unit, you maneuver "in" faster and "out" faster, in the most limited spaces. Then, too, Athey Rear Dump Trailers are matched and balanced to Cat DW20 and DW21 Tractors, assuring long life and low operating costs. You'll be money ahead if you "tailor" your hauling unit to best suit your job!

Speeds Loading in Tight Quarters — The Big DW21-PR21 Tractor-Trailer easily turns non-stop in a 34-foot cut. Wide, low body speeds shovel swings . . . handles more loads, faster . . . top maneuverability means top profit!

Athey

Flexibility and Performance,

"Tailor-made" for Your Job

SIDE DUMP

for faster operation on long hauls . . . non-stop dumps.

Built-in Stability, Non-Stop Dumping. The PD20 Side Dump Trailer keeps your production moving, dumps evenly and cleanly "on the roll". Big tires help compact the fill. Stabilizing jacks provide safety while dumping. One-way traffic saves time, prevents traffic tie-ups.

On long, fixed hauls, the Cat-Athey Side Dump unit combines maximum production and lowest cost. Loads travel along at speeds up to 32 MPH. On-the-move dumping at the fill . . . instant spotting at the hopper. No wasted time in stopping and backing to dump.

More even distribution of material at fills, into cars, or crushers. One-way traffic on cycles further speed up the job, and avoid hazards. The PD20 has built-in stability while dumping with self-contained hydraulic stabilizing jacks. Another advanced design feature from Athey's 33 years of engineering and manufacturing experience. It will pay you to investigate the high-speed, high-production PD20 Side Dump Trailer.

ATHEY PRODUCTS CORPORATION

5631 West 65th Street, Chicago 38, Illinois

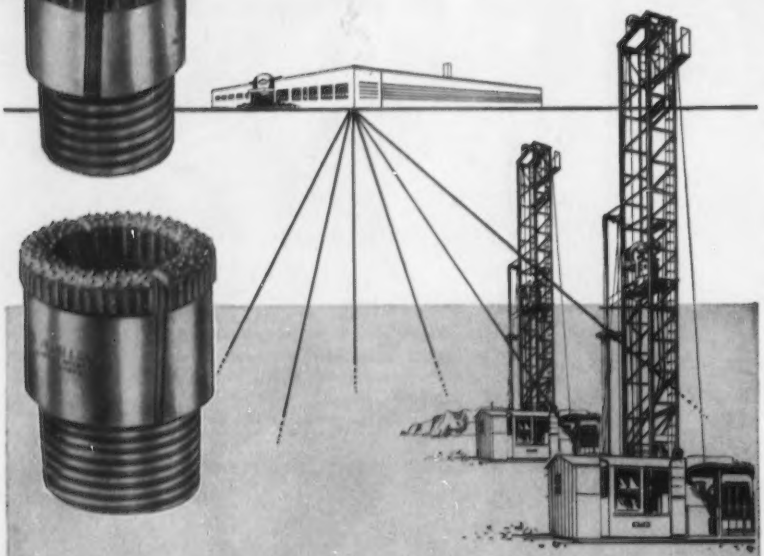
Clips Minutes Off Cycle Time — on the haul, at the shovel, and at the dump, the PD20 speeds up each operation. "Hi-ball" loads with safety at travel speeds up to 32 MPH. Wide target cuts down loading time. Athey Side Dump Trailer features save profitable minutes. It all adds up to faster production, more profit.

out of the factory into the ground . .

and a champion every foot of the way

J. K. Smit Diamond Drill Bits are designed and engineered in our own plant, and manufactured with one purpose in mind: to give you maximum cutting speed, plus the most economical footage under any possible hole conditions.

Problem	Solution
Non-abrasive formations	HARDHED matrix
Average drilling conditions	HARDHED 40 matrix
Extremely abrasive formations	HARDHED 55 matrix



In addition, experienced personnel are at your service for consultation on any phase of diamond drilling.

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Are You Seeking New Ideas On EXPLORATION?

Be sure to check through pages 19-38 of this Guidebook for the latest developments in:

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Four AAF Favorites for Mining Dust Control

For extremely fine particles and materials that should be reclaimed dry.

AMERjet Fabric Arrester

Continuous reconditioning of cleaning tubes by reverse jets of high pressure air permits five times greater velocities through the media than ordinary fabric collectors. Collected material is a uniform product, requires no remixing. Compact design means easy, low cost, on-the-job assembly close to dust source. Write for Bulletin 279.

For medium concentrations of fine particles.

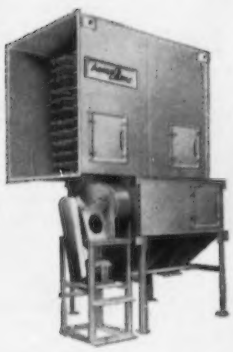
Type W ROTO-CLONE

Dynamic Precipitator

The addition of water sprays extends the effectiveness of this dynamic precipitator to the collection of the finest, lightest dust particles. Lowest priced wet dust collector in its class (1,500 to 50,000 cfm). Combines collector, exhauster, motor and drive in one compact, shop-assembled package. Write for Bulletin 274.

For high concentrations of dry, granular particles in large volumes.

AMERclone Dry Centrifugal

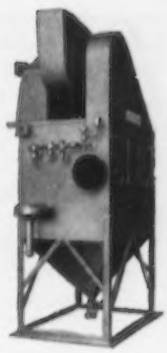


AMERclone offers collection efficiencies equal to or better than other available units with important space savings due to the 333 cfm cleaning capacity of a single 4"-diameter tube. And efficiency *remains* constant over a wide range of exhaust volumes. Thick-wall gray iron castings greatly minimize abrasive effect. Write for Bulletin 291.

For heavy-duty loadings of all sizes.

Type N ROTO-CLONE

The high cleaning efficiency of this hydrostatic precipitator is the result of the combined action of centrifugal force and thorough intermixing of water and dust-laden air. Compensating water level assures maintained efficiency. Collector, exhauster, motor, drive and hopper in one shop-assembled package. Hopper can be arranged for sluicing or for ejecting dewatered sludge. Write for Bulletin 277.



AAF herman nelson

American Air Filter
COMPANY, INC.
193 Central Avenue, Louisville 8, Kentucky
American Air Filter of Canada, Ltd., Montreal, P. Q.

AAF Dust Control Equipment

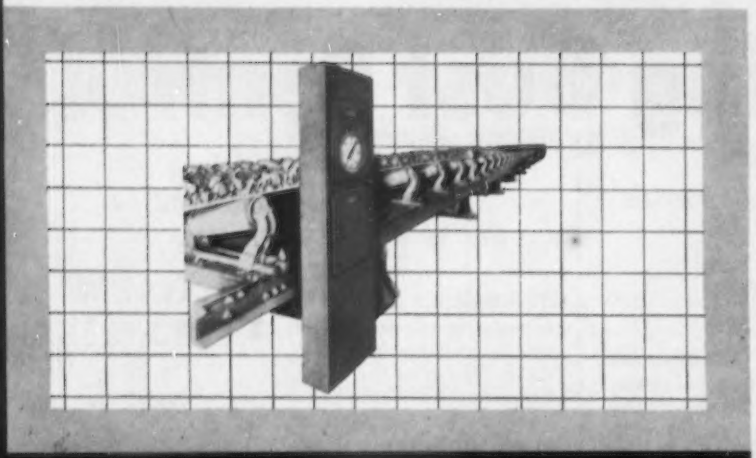
Air Filters and Precipitators

— BETTER AIR IS OUR BUSINESS —

Cycoil Oil Bath Air Filters

Herman Nelson Unit Heaters

COSTS DOWN! PRODUCTION UP!



...WITH BUILDERS Conveyoflo

CONVEYOFLO Meter is a precision unit of rugged construction for accurate totalization of all belt-conveyed materials. With the addition of a controller, a preset rate of delivery will be maintained. With the addition of a pneumatic transmitter, it can pace proportionally the delivery from auxiliary feeders in automatic processing systems. Conveyoflo comes as a complete unit including conveyor, drive, and weighing mechanism . . . or can be installed in your present conveyor lines. Here is thoroughly reliable, service-proven equipment.

FEATURES

- ACCURACY — within plus or minus 0.4 of 1% of full scale load over a 10:1 range.
- CONTINUOUS INTEGRATION — automatically compensates for variations in belt speed . . . provides accurate response to rapid load variations.
- OVERLOAD PROTECTION — weighing element and calibration not subject to damage by overloading.
- PNEUMATIC OPERATION — inherently explosion-proof.
- COMPACT — weight sensing mechanism completely contained within conveyor structure. Panel located above or below conveyor as desired.

ACT TODAY!

Bulletin 550-H4A gives complete data on Conveyoflo operation, accuracy, totalizer head, weigh spans, etc. Request your copy from **Builders-Providence, Inc.**, 391 Harris Ave., Providence, R. I. . . . division of

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ELECTROMAGNETIC SURVEY UNITS (SE-100)

For locating base metal deposits which may not produce marked magnetic anomalies. Compact. Portable. $2995.

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Designed for one-man operation. Faster coverage, lower labor cost. Sensitivity: 10 gammas or more per scale division. $1995.

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For delineating structures with abnormally high magnetic characteristics and ground checking magnetic maps. $610.

SELF-POTENTIAL (SP-5) & RESISTIVITY UNIT (SP-5R)

For primary gold and base metal exploration to reveal location of disseminated sulphides. Four electrodes. Self-potential only, $715. With resistivity attachments, $1210.

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The simple, economical instrument for locating drift-covered magnetite and pyrrhotite, or ultra basic rock intrusives. $185

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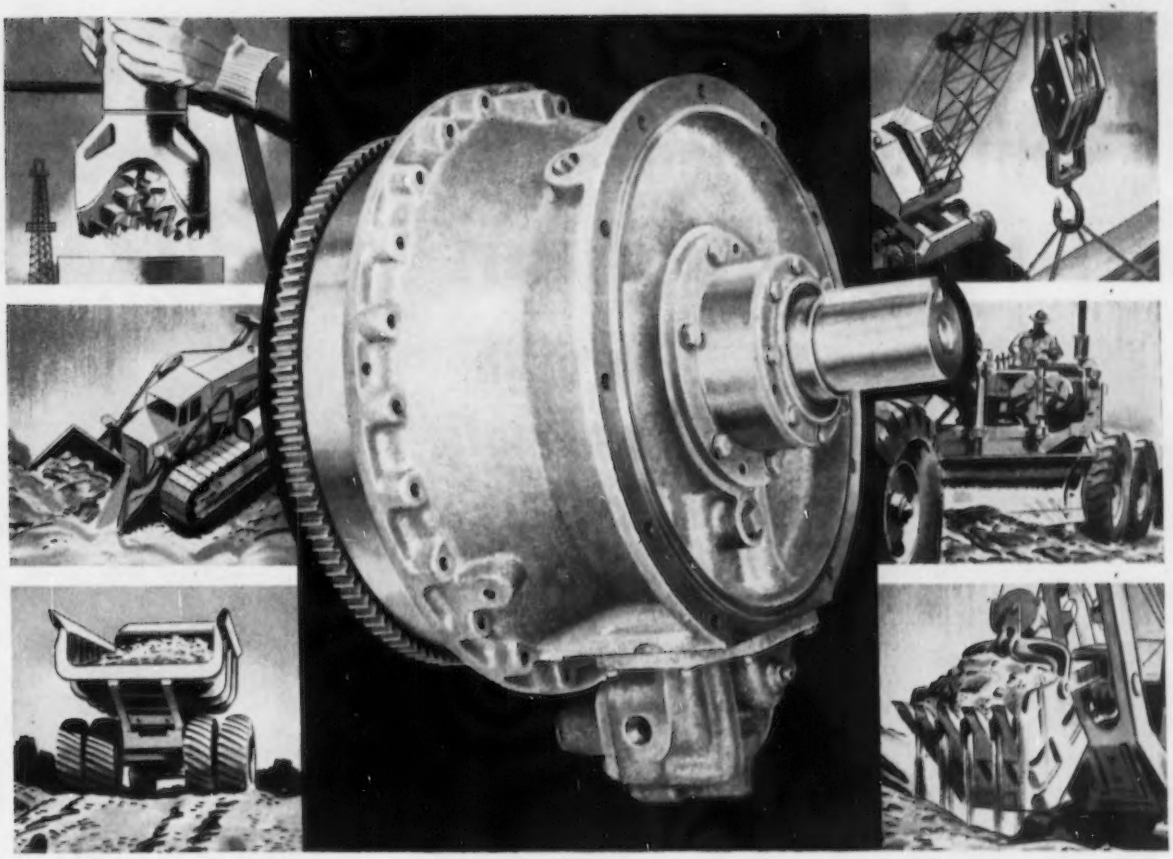


Versatile is the word for the Torqmatic 500

NAME the gasoline- or Diesel-powered equipment you buy or build in the 150 to 350 horsepower range and it's a sure bet that it's available—or will be soon—with the Series 500 TORQMATIC, *the world's most versatile torque converter.*

Scores of manufacturers—making such varied equipment as cranes, shovels, drilling rigs, log loaders, ditchers, industrial locomotives, scrapers, graders and off-highway trucks—specify the TORQMATIC 500 in the equipment they build, and with good reason.

In one standard housing it gives them a choice of 4 ranges, 7 torque ratios—*and* permits operators to standardize on *one* type of converter for *all* their equipment within the horsepower range.

In many applications it permits the use of lower horsepower engines with no reduction in *working* power because the TORQMATIC 500 multiplies engine torque anywhere from 250% to 360%—*and* means equipment owners will cut operating costs and get more work done per shift.

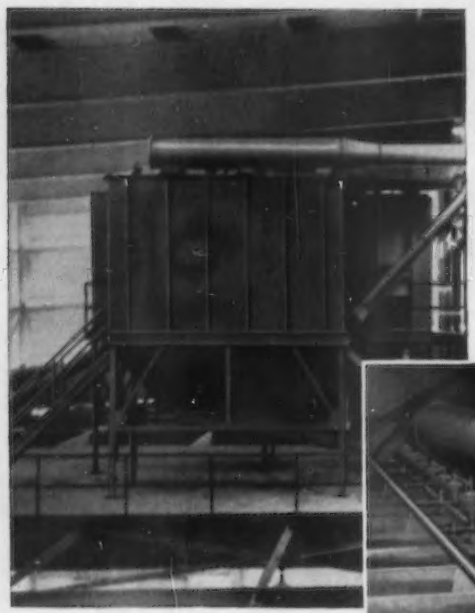
For full details on the Series 500 TORQMATIC Converter in your equipment write to:

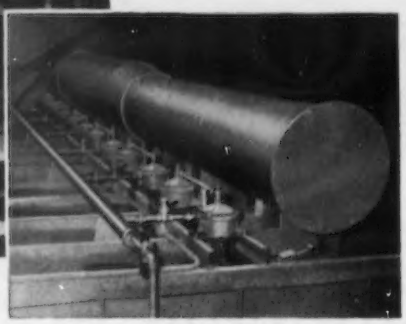
Allison Division of General Motors
Box 894M, Indianapolis 6, Indiana

GM TORQMATIC *Allison* TORQMATIC DRIVES

Norblo gives you continuous peak-load Dust Collection

through automatic bag cleaning





Plants running full blast can ill-afford down time for equipment repairs and maintenance. Dust collection around the clock without interruption is commonplace with Norblo Automatic Bag Type Arresters.

Complete time-cycles for progressive automatic bag shaking are controlled by highly efficient electric timers. Only one compartment is cut out at a time, and that for just a few seconds, with *no* drop in efficiency for the installation as a whole. Norblo's compartment construction is the time-saving solution to inspection, maintenance and repair in busy plants . . . For "good housekeeping" or for salvage, Norblo Automatic installations have many design advantages wherever continuous high recovery of industrial dusts and fumes is important.

It pays you to write at once for latest information on Norblo Automatic Bag Type Dust Arrester that assures constant high efficiency dust handling.

THE NORTHERN BLOWER COMPANY

6410 Barberton Ave., Cleveland 2, Ohio OLympic 1-1300

Norblo ENGINEERED DUST COLLECTION SYSTEMS FOR ALL INDUSTRIES

Remember this

MERRICK

guarantees

ACCURATE WEIGHT

wherever you

FEED OR CONVEY

Remarkable FEEDOWEIGHT!

A self-contained automatic conveyor scale. Has automatic gate for feed rate control. Feed regulator operates gate, without restraint on scale beam. Feeds bulk material BY WEIGHT; automatically totalizes weight of materials fed. Simple operation. Slow moving parts for long life. Easy to install, maintain.

WEIGHS AND TOTALIZES WHILE CONVEYOR IS RUNNING

WEIGHTOMETER

Gives a continuous automatic, accurate totalized weight record while material is in motion on conveyor. It weighs without interrupting conveyor service. Used with any size belt conveyor, horizontal or inclined. Guarantees an accurate and dependable constant check on production of raw and washed coal, ore, etc.

MERRICK SCALE MFG. CO.

Engineers and Mfrs. of Automatic Weighing Equipment

PASSAIC, N. J.

Schramm, Inc.

MANUFACTURERS OF PORTABLE STATIONARY AIR COMPRESSORS AND CONSTRUCTION TOOLS
MAIN OFFICE AND FACTORY—WEST CHESTER, PA., U. S. A.

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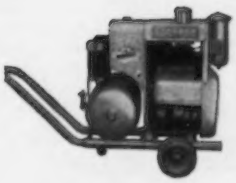
MODELS 20 and 35



Gasoline engine driven compressors, with push button electric starting, delivering respectively 20 and 35 c.f.m. @ 100 p.s.i. are useful for general maintenance, painting, tire service, digging, backfilling, pressuring lubricating equipment. Also available skidded for use in pickup truck.

½ to 5 h.p. STATIONARY

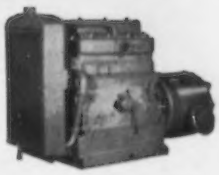
Electric motor driven compressors for shop use, base mounted or on receiver—½ to 5 h.p. V belt drive only, 7½ to 15 h.p. V belt or direct drive—start and stop or continuous operation with unloading.

MODELS 75 and 125

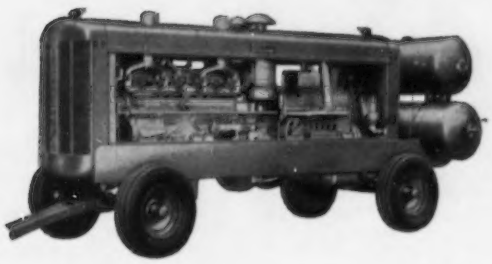
Two wheel mounted 75 and 125 c.f.m. gasoline engine driven compressors will operate hand held rock drills or light wagon drills, furnish air for forges and furnaces and be generally useful around a mine. Also available skidded.

INDUSTRIAL COMPRESSORS

Vertical, water cooled compressors, 20 to 150 h.p., running water or radiator cooling—operate efficiently in hot or cold places—V belt or direct motor drive—all types of mountings.



UNISTAGE MODELS 125 to 600

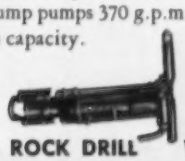


125, 210 and 315 c.f.m. sizes available with either gasoline or diesel engine, 600 c.f.m. diesel only. For continuous service at 40-125 p.s.i.g. and intermittent service to 200 p.s.i.g. Pneumastat makes the amount of air produced fit the job. The most economical compressors for the big jobs.

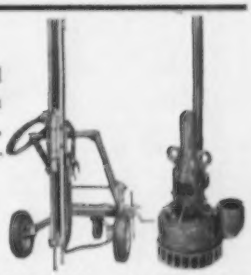
PNEUMATRACTOR

Self-propelled 125 c.f.m. gasoline engine driven air compressor—does anything a wheel tractor will do—mounts 1 yard loader, 7′ bulldozer blade, backhoe, winches, etc. A universal piece of equipment.

20, 45 and 55 pound class hand held drills and wagon drills with 45, 55 and 126 pound (4″) drifters, and sump pumps 370 g.p.m. maximum capacity.

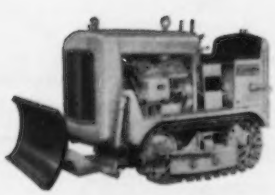


ROCK DRILL



WAGON DRILL SUMP PUMP

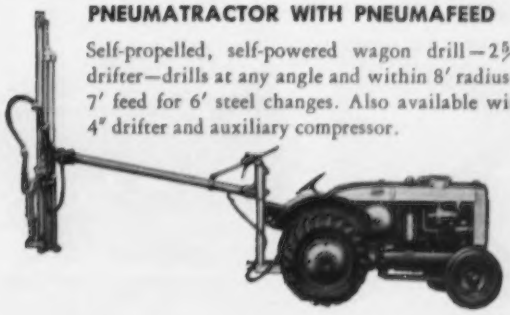
MODEL 60 CRAWLER



A self-propelled 60 c.f.m. gasoline engine driven air compressor on tracks—will go anywhere, easily maneuvered, can mount hydraulically controlled blade or ¼ yard bucket, or winch.

PNEUMATRACTOR WITH PNEUMAFEED

Self-propelled, self-powered wagon drill—2⅝″ drifter—drills at any angle and within 8′ radius—7′ feed for 6′ steel changes. Also available with 4″ drifter and auxiliary compressor.



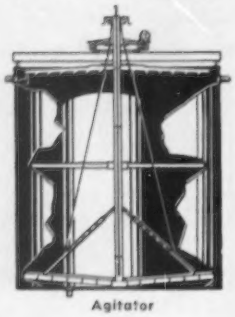
HARDINGE COMPANY, INCORPORATED

YORK, PENNSYLVANIA

NEW YORK · TORONTO · CHICAGO · HIBBING · HOUSTON · SALT LAKE CITY · SAN FRANCISCO

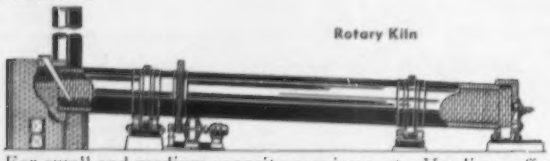
AGITATING

Hardinge combined mechanical and air Agitators are used to mix, agitate or store clay slurries, as well as metallurgical and chemical pulps. Compressed air is delivered to the bottom of the torque tube (which acts as an air lift) and to various points near the ends of the rotating scrapers. Pulp is fed and withdrawn continuously or intermittently, as desired. The drive mechanism is supported on ball bearings in an oil-filled, totally enclosed housing. The scraper raising winch is in easy reach and away from possible splash of pulp. Bulletin 31-E-18.



Agitator

CALCINING



Rotary Kiln

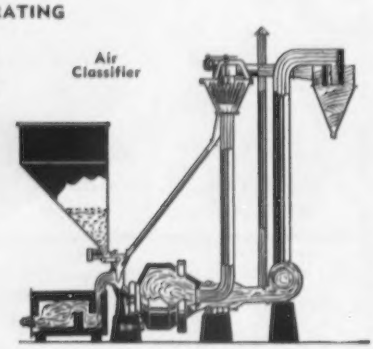
For small and medium capacity requirements, Hardinge offers the Ruggles-Coles Rotary Kiln for continuous calcining, roasting or oxidizing operations. It may be fired by oil, gas or pulverized coal. Bulletin 16-D-18.

Hardinge also makes a line of vertical shaft kilns, both direct-fired and mixed-feed types. The Keystone Lime Kiln is ideal for smaller operations using coal, coke, oil or gas for fuel. Bulletin 23-A-18.

CLASSIFYING • SEPARATING

Dry Classifiers

The Hardinge "Gyrotor" Air Classifier, operating in conjunction with the Hardinge Mill, is a compact, self-contained unit of unusual efficiency. The material is conveyed without auxiliary apparatus to any convenient location in the building. The Hardinge "Gyrotor" Air Classifier provides extremely close product control. Bulletin 17-C-18.



Air Classifier

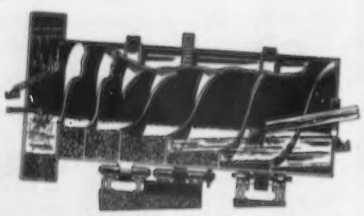
Wet Classifiers

The Hardinge Counter-Current Classifier is used for making size separations of ores and sands. It consists of a slowly rotating drum, on the inner surface of which is attached a screw flight. Will operate in closed circuit with a grinding mill without the use of conveyors or pumps. The Hardinge Hydro-Classifier is a large-volume classifier for fine separating problems. Bulletin 39-B-18.

Hydro-Classifier

Heavy Media Separators

The Counter-Current unit is also used as a Heavy-Media Separator. The "Sink" is separated from the "Float" by the screw flights as shown. The unit has only one moving part, is very efficient and will start up fully loaded. Bulletin 39-B-18.



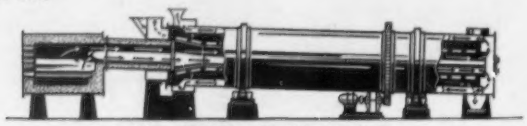
Counter-Current Classifier, Heavy-Media Separator

COOLING

Ruggles-Coles Rotary Coolers are employed for cooling hot materials after high temperature drying or calcination. There are three types: the air type, utilizing an induced cool air stream; the partially submerged type (illustrated); and the water spray type with exterior sprays cooling the shell. Bulletin 16-D-18.

Rotary Cooler

DRYING



Class XB Double-Shell Rotary Dryer

There are six distinct types of Ruggles-Coles double- and single-shell Rotary Dryers, designed for direct, indirect and steam heat. Bulletin 16-D-18.

Class XA — This double-shell, semi-direct-heat dryer has the highest thermal efficiency and lowest fuel consumption of any rotary dryer manufactured. Particularly adapted for coal drying.

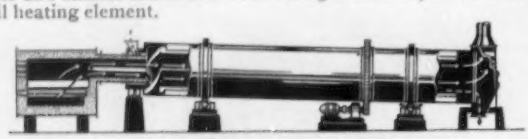
Class XB — A double-shell, indirect-heat dryer designed to handle such materials as kaolin, chalk, whiting, china clay, pigments, fuller's earth.

Class XC — A rotary steam tube dryer for drying materials that are injured by high temperature such as brewers' grain, cotton seed, starch feed, tobacco stems and corn germs.

Class XF — Single-Shell, counter-flow dryer for high drying temperatures.

Class XH — A single-shell, parallel-flow dryer, especially designed to handle flotation concentrates without sticking and without excessive dust loss.

Class XW — Used almost exclusively for drying inorganic salts and similar materials. It is a single-shell dryer with steam coil heating element.

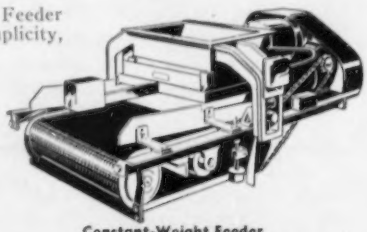


Class XH Single-Shell Rotary Dryer

FEEDING

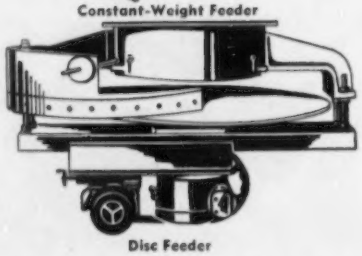
The Hardinge Constant-Weight Feeder measures by weight, not volume, thus compensating for variations due to changes in specific gravity, bulking or size of material. The feeder is quite accurate, and it affords automatic feed control for crushers, pulverizers, mixers, dryers, kilns, furnaces and conveyors. The feeder is bin-supported, requires little headroom. An indicating, totalizing or recording tachometer may be attached to the feeder drive to provide a weight measurement or record of the feeding operation.

The Hardinge Disc Feeder is outstanding in its simplicity, sturdiness and ease in adjustment. Particularly suitable for handling bulky, sticky, hot materials. Economical in cost and requires a minimum of headroom.



Constant-Weight Feeder

Other Hardinge regulating feeders are: the Volumetric Belt Feeder which provides uniform volume feeding control; and the Volumetric Non-Flooding Drum Feeders which employ the rotary pocket principle. Bulletin 33-E-18 describes the entire feeder line.



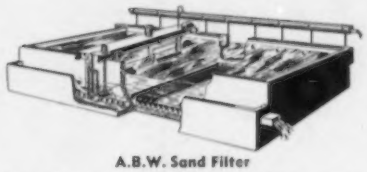
Disc Feeder

HARDINGE COMPANY, INCORPORATED

YORK, PENNSYLVANIA

NEW YORK · TORONTO · CHICAGO · HIBBING · HOUSTON · SALT LAKE CITY · SAN FRANCISCO

FILTERING



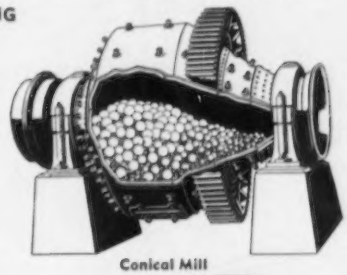
A.B.W. Sand Filter

The Hardinge Automatic Backwash Rapid Sand Filter cleans its own filter bed, a section at a time, automatically, without shut-down or change-over. Primarily adapted to the filtering of water containing small amounts of suspended particles that cannot be properly collected in settling basins or clarifiers. Used for filtering municipal water supplies, industrial water supplies, and certain presettled industrial waste waters to permit their re-use. Bulletin 46-A-1.

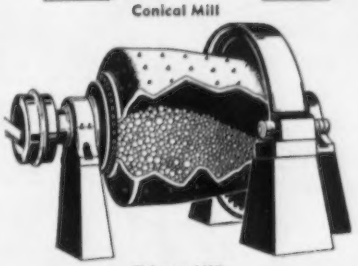
GRINDING—PULVERIZING

Conical Mills

The shape of the Hardinge Conical Mill causes a rapid circulating and classifying action within the drum, which increases the capacity for power expended over other types. The range of grinding is large, due to the segregation of the sizes within the mill. Sizes range from 2 feet to 10 feet with capacities from a few pounds per hour to 100 tons per hour. Bulletin 17-C-1 gives dry grinding applications; Bulletin AH-389-1 wet grinding.



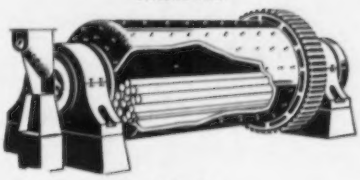
Conical Mill



Tricone Mill

Tricone Mills

Built on the same principle as the Conical Mill, the Tricone Mill offers greater grinding volume for a given amount of floor space than any other tumbling mill built. Extremely efficient. Ideal for large tonnages. Sizes up to 12 ft. diameter. Bulletin AH-414-1.



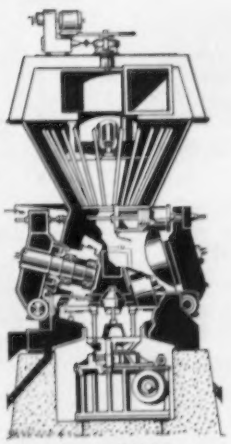
Rod Mill

Rod Mills

Steel rods are employed as grinding media. Ideal for producing minimum oversize in open circuit grinding. Convex or conical heads reduce friction, prevent congestion of charge at the ends, and align the rods. Available with either end, or center, peripheral discharge, as well as trunnion overflow. Bulletin 25-C-1.

Disc Roll Mills

An adaptation of the German "Loesche Mill." A roller-mill with rotating grinding table and pneumatically-loaded rolls for complete flexibility of operation. The "Gyrotor" Classifier, combined with the Disc Roll Mill, provides a highly-efficient dry-grinding device, ideal for relatively soft minerals. Bulletin 52-1.



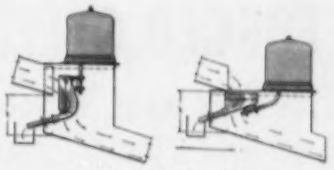
Disc-Roll Mill and "Gyrotor" Classifier

"Electric Ear"®

A revolutionary principle of control that automatically regulates the feed rate of a mill to keep it operating at maximum efficiency by "listening" to the sound. Mill capacity is increased 10% to 20%. Bulletin 42-A-1.

SAMPLING

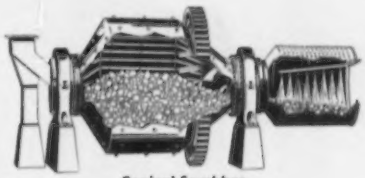
The Hardinge Automatic Sampler is simple in design, rugged in construction and offers a wide selection of sampling intervals and cutter openings. Accurate, continuous and trouble-free operation. Available for wet or dry processes. Wet models illustrated; type "A" cutter (left), type "B" (right). Bulletin 47-1.



Automatic Wet Samplers

SCRUBBING

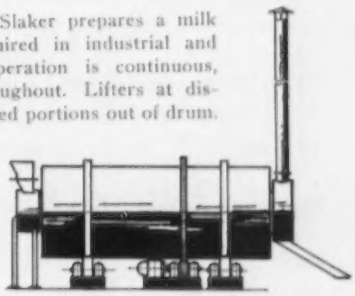
The Hardinge Conical Scrubber cleans by mass contact and natural displacement. This action removes dirt and silt without wear on the scrubber. The classifying action of the cone holds back the large clay balls until properly disintegrated. Foreign materials, such as sticks, vegetation or large pieces of metal, can do no harm. Power required is low, and water requirements are considerably less than that of other methods. Repair costs are negligible. Bulletin 37-B-1.



Conical Scrubber

SLAKING

The Hardinge Lime Slaker prepares a milk of lime slurry as required in industrial and chemical processes. Operation is continuous, with close control throughout. Lifters at discharge end dump unslaked portions out of drum. Impurities and grit in the discharge can be separated by a Hydro-Classifier if desired. Bulletin 50-1.

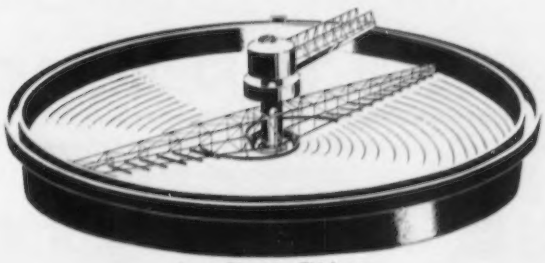


Lime Slaker

THICKENING

The distinctive features of the Hardinge Thickener are the spiral scrapers, which clean the bottom of the tank with each revolution, and the "Auto-Raise" driving mechanism which automatically lifts the scrapers away from an overload or obstruction in the tank bottom, thus eliminating costly breakdowns and delays. Can be operated very slowly, causing a minimum of disturbance. Produces a clearer overflow and a thicker discharge than other types. Small thickener mechanisms are supported on beams, spanning the tank. The large units carry the mechanism on a central concrete pier. Bulletin 31-E-18.

Small-Diameter Thickener



Large-Diameter Thickener

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Moly Chrome Balls – Unsurpassed in penetrating hardness, toughness, uniformity of roundness and size. Unusually high volumetric hardness (610-665 Brinnell) so ball retains hardness even after substantial reduction in diameter. ¾" to 5" diameter.

"ICDH" (Improved Carbon Deep Hardened) Balls – Available from AFCO only. Cost no more than ordinary carbon balls, wear 6 to 10% longer. ¾" to 5" diameter.

Concavex Balls – ¾" to 2" diameter.

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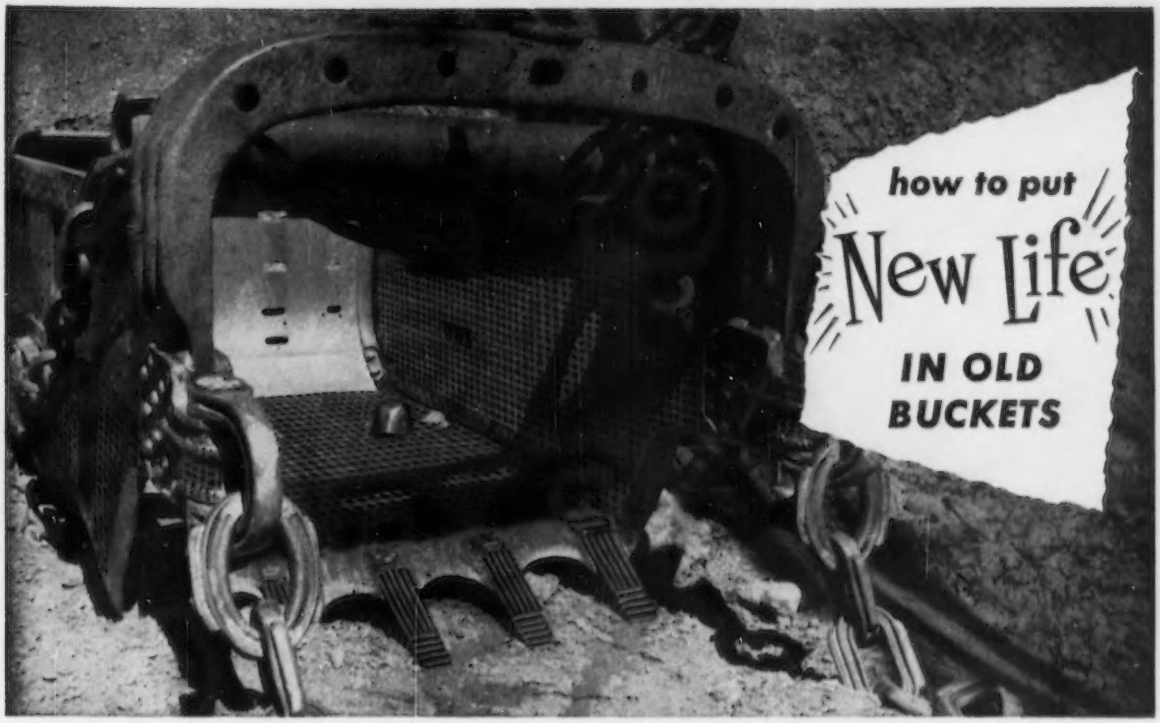
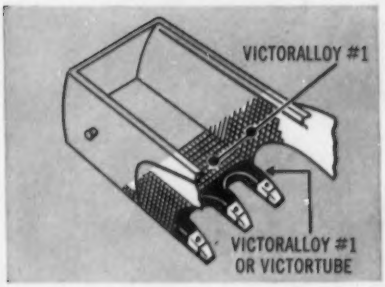
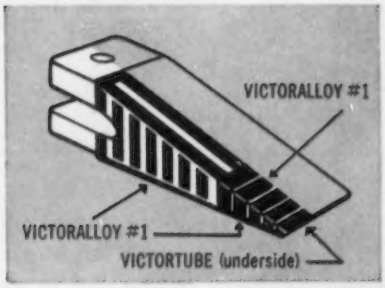


USE VICTOR HARDFACING





Buckets . . . Apply VICTORALLOY #1 to top and bottom of bucket lips in overlapping beads. Protect other parts or areas showing wear with stringer beads of VICTORALLOY #1. Use 3/16″ coated VICTORALLOY #1 at 170 to 190 amperes, a.c. or d.c., or ¼″ at 200 to 225 amperes. If wear is unusually severe, substitute VICTORITE on bucket lips; use 3/16″ coated at 120 to 150 amperes, a.c. or reverse-polarity d.c.

Teeth . . . Apply VICTORTUBE to underside from point upward about 2″, and VICTORALLOY #1 to upper side of tooth same distance. Use stringer beads of VICTORALLOY #1 on balance of upper and lower surfaces, and on edges. Use 3/16″ coated VICTORTUBE at 130 to 160 amperes, a.c. or reverse-polarity d.c., and 3/16″ coated VICTORALLOY at 170 to 190 amperes, a.c. or d.c.

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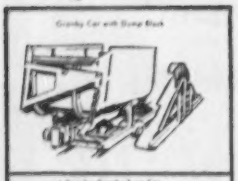

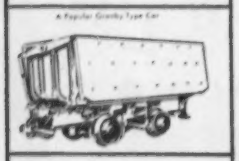

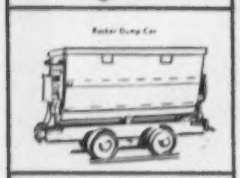

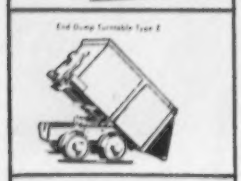

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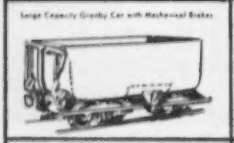

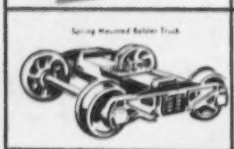

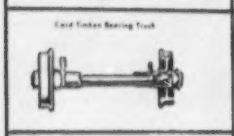

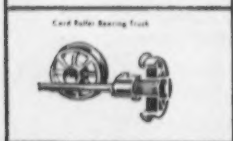

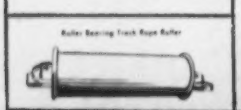

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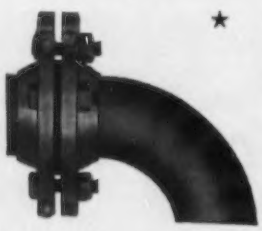

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"GOODITE" FLEXIBLE PIPE. Same construction and advantages as "Kemite" Duct, above, but available in larger sizes—up to 12", I.D.

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"SUPER TRIPLE-S." Goodall's finest grade. Heavy duck carcass, high tensile rubber covers and strong friction between plies. Designed to carry run-o-mine coal, ores, slag and crushed limestone up to 10", wet or dry. Widths up to 48".

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Friction surface, raw edge construction, especially built for most severe service. Minimum stretch and firm contact with pulleys at high speeds. Highest quality skim friction between plies. 35 oz. silver duck.

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"WEAR KING" ® BOOTS—Identical in quality with above, but without "Toe-Saver." Hip, Style MB345. Storm King, Style MB799. Short, Style MB945.

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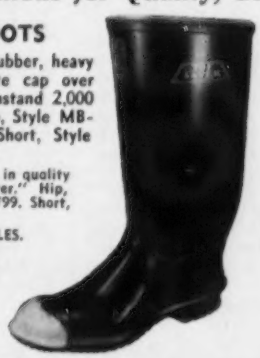

MINER'S PACS Top quality black rubber Lace Pacs, Style ML-975, 16" high; Style ML-760, 15" high. Cushion insole. Cleated outsole. "Toe-Saver" Safety Toe. Also non-lace "Terra Haute" pacs, Style ML-271, in otherwise same construction. Other boots, workshoes, arctics and rubbers, built for extra wear and comfort.

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Items too numerous to describe here, in rubber, oiled and latex . . . all designed to afford maximum protection plus comfort in every kind of work. Style 338 coat is a long-time favorite . . . double back; corduroy-lined collar; length 49".

SAFETY HATS

"Hardboiled" Safety Hats in fibre glass and aluminum. Easiest to wear, yet providing maximum protection. Also, miners' caps, with or without lamp brackets.

TUNNEL SUITS

Style 80 jacket with Style 81 Overall makes the ideal suit for underground work. Other suit combinations to meet every preference or need.

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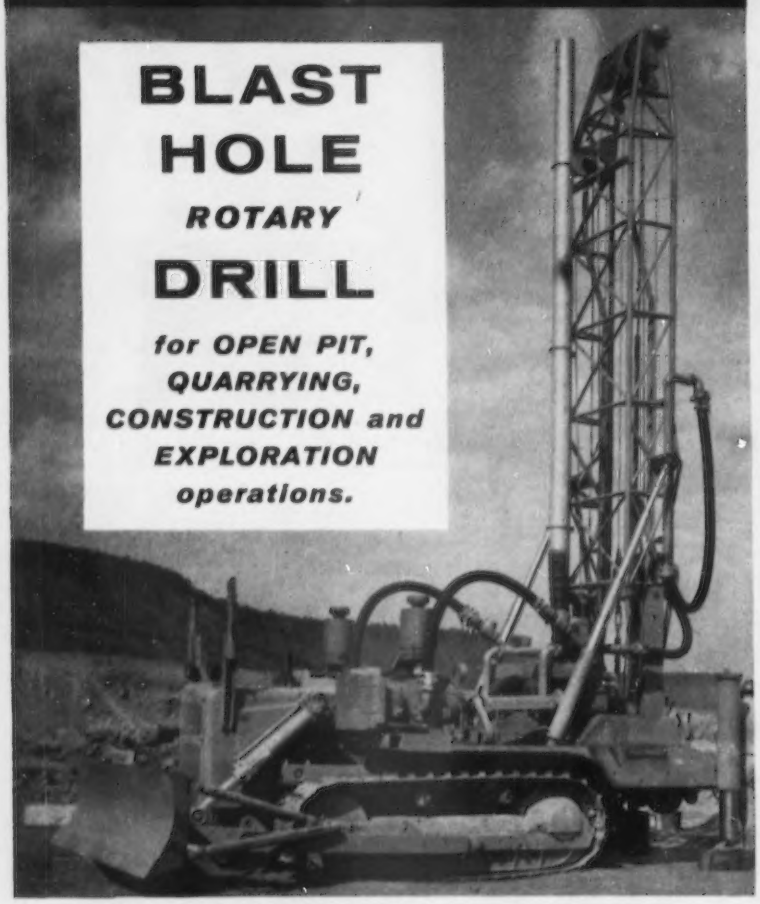
Write for catalog describing the complete Goodall clothing and footwear line.

OUTSTANDING

BLAST HOLE ROTARY DRILL

for OPEN PIT, QUARRYING, CONSTRUCTION and EXPLORATION operations.



PORTADRILL model 6TA
REG. U.S. PAT. OFF.

Caterpillar D6 Diesel Prime Mover

Unitized. No other equipment needed

Up to 9" blast holes 150' deep

Cuttings collector or water spray dust control

One or two man operation

Proven in 2 years of field testing.

FASTER DRILLING: The 6TA averages a foot per minute or more of 9" hole under normal drilling conditions. The efficient air system for removing cuttings gives 1,000 CFM and the resulting high air velocity together with 27,000 lbs. available down pressure are two of the many features of the 6TA that speed blast hole drilling. Prime mover furnishes all drilling power through a heavy duty transfer case and power take-off.

LOWER INITIAL COST—LOWER OPERATING COSTS: The lower initial cost combined with economical operation, high mobility and less manpower will speed your blast hole work and reduce your drilling costs.

Complete specifications, price and delivery date on request

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- Small, lightweight, only 9 oz., 2¾"x3"x 1⅛"...easy to carry in pocket, on belt.
- Shows direction to 1°...level, slope or grade within 1°.
- Used in hand or on tripod.
- *Made to last a lifetime.*

*BRUNTON a registered trademark of

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Over 50,000 Brunton Transits since 1896

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YOU WANT ROSS CHAIN FOR REAL FEED CONTROL . . .

A Ross Chain Feeder is your guarantee of perfect flow control of ANY size ores or rock . . . from storage bins and open dump chutes to crushers, conveyors, screens . . . anywhere . . . at lowest operation and maintenance cost. Other "Ross" units include Ross Drop-Bar Grizzly Feeder and Ross Two-Roll Grizzly.

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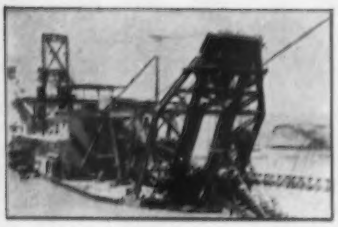

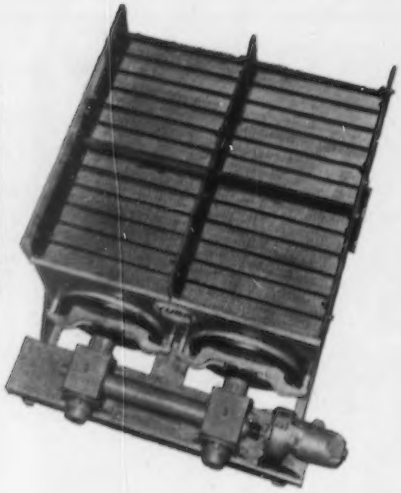

M-8 jig developed by YUBA for concentrating ores on dredges and in mills. It's designed to save space, reduce downtime, increase production.

FULL AREA OF

YUBA JIG BED

IS COMPLETELY ACTIVATED

YUBA jig action is positive. You set the speed and stroke wanted, get constant, even pulsations that create surface action over full area of bed. Result: YUBA M-8 jigs have a large material capacity per flow line under full control.

Any material that can be concentrated can be handled successfully in YUBA jigs, including . . .

CASSITERITE	RUTILE
GOLD	SCHEELITE
PLATINUM, ETC.	GARNETS
MONAZITE	SAPPHIRES
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Design Eliminates Trouble Spots

Stainless steel hutch valves and screens prevent rusting and clogging. Rubber seal between screen grids and basket confines action to screen area. Long-wearing hutch diaphragms of reinforced synthetic rubber can be replaced easily.

"Package Drive" units for YUBA jigs are interchangeable, completely enclosed, self-lubricating. Generous use of anti-friction bearings reduces power required. Maximum frequency of a 4-cell M-8 jig is 350 at ¼". Stroke adjustments between ¼" minimum and 3" maximum are easily and quickly made, enabling you to closely control jig action.

YUBA jigs can be installed in new or old dredges or mills to supplement existing jigs or to replace other concentration methods. Send us data on ore, feed sizes and present installation if you wish us to furnish details to adapt YUBA jigs to your operation.

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YUBA MANUFACTURING CO.

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Minerals, Concentrates, Wastes or other materials, via a dependable Riblet Aerial Tramway.

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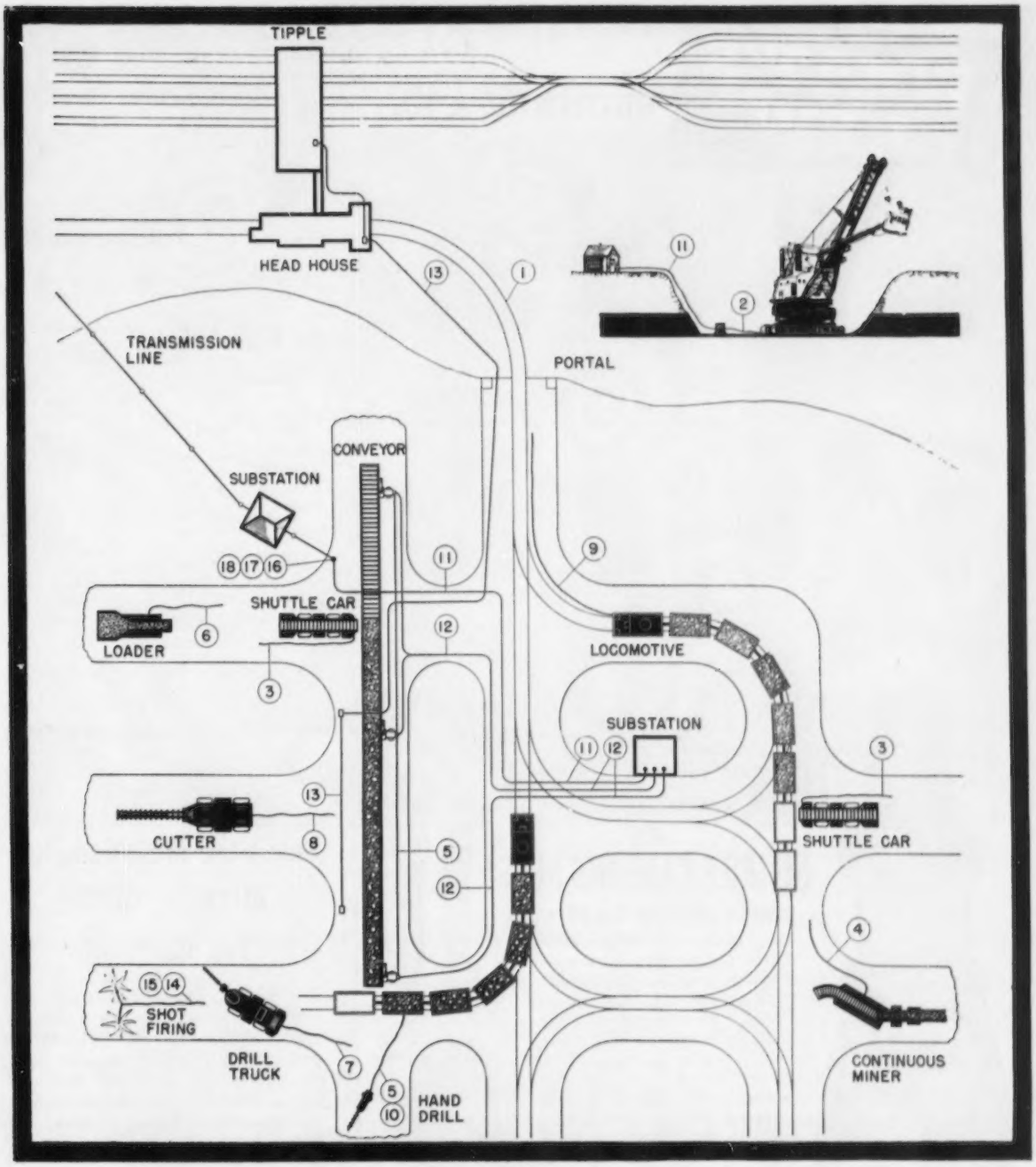

Choose your mine cable from this page

It takes a miner to understand mine problems.

And at Anaconda we're miners ourselves—as well as the world's largest manufacturer of mine wire and cable.

From tipple to mine face there are Anaconda wires and cables—designed, made and tested by mine cable experts—for *every* job in the mechanized mine. These wires and cables have proved records of safety and economy in mines all over the world.

Ask your Anaconda Distributor for these Anaconda products:

1) Trolley wire; 2) Shovel cable; 3) Shuttle-car cable; 4) Continuous mining-machine cable; 5) Remote-control and heavy-duty drill cord; 6) Loader cable; 7) Drill-truck cable; 8) Mining-(cutting) machine cable; 9) Gathering-locomotive cable; 10) Hand-drill cord; 11) Mine-power cable; 12) Low-voltage power and feeder cable; 13) Telephone cable; 14) Shot-firing cord; 15) Blasting-cap wire; 16) Borehole and mineshaft cable; 17) Anaconda suspension unit for borehole cable; 18) Armored cable suspension unit.

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"600" COUPLING | 3½" ROK-BITS | 3" ROK-BITS | 2¼" ROK-BITS | 2½" ROK-BITS | "600" THREAD

BRUNNER & LAY "600" ROK-BITS

Bits fit directly on G-D and other similar type threads. Non-rifling "X" design GIVES YOU A ROUND HOLE TO LOAD. (3" and 2¼" bits also in cross types). Write for folder BDC-56.

4½" ROK-BITS | J-7.50 COUPLING | 4" ROK-BITS | J-7.50 THREAD | 3½" ROK-BITS

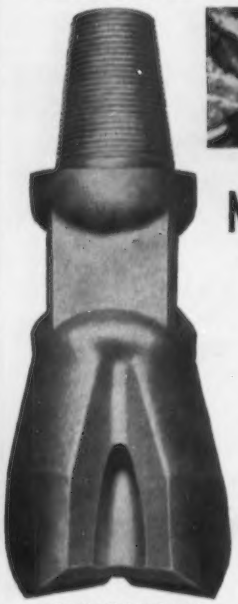
BRUNNER & LAY J-7.50 ROK-BITS

Bits fit directly on J-7.50 thread, no adapter needed. Non-rifling "X" design. Wider chip channels. Ask for bulletin BJ756. Also above bits in 800 series.

2¼" ROK-BITS | 2" ROK-BITS

BRUNNER & LAY "400" ROK-BITS

Non-rifling "X" design. No adapter needed.



BRUNNER & LAY 6" ROK-MASTER for use with I-R Quarrymaster drill. 2 x 3 A. P. I. threads.

NO HOLE CAVE-INS HERE!

thank to small-hole Rok-Bit drilling

Drill blast holes faster—load them easier, with no costly cave-in problems by using (1) airlegs, (2) drill small holes, (3) with carbide Rok-Bits on Brunner & Lay rods. For proof of what this accepted 3-step technique can mean to your operation in keeping drill costs down, output up and drillers happy—contact our nearest plant. **SMALL or LARGE HOLE Drilling, we have the bits for them all.** Ask for Bulletin B-1.

Intra-Set Drill Steel—carbide insert—gauge sizes: 1¼" thru 2¼"

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The Buyers' Guide Section in this Guidebook is the most comprehensive listing of manufacturers available in the industry. Product listings are based on information obtained from all known manufacturers serving the field—a company-by-company check conducted by the E&MJ editors just for this 1956 edition.

Manufacturers advertising in this issue appear in bold-faced type in the Buyers' Guide. You'll find more helpful product information in their advertisements.

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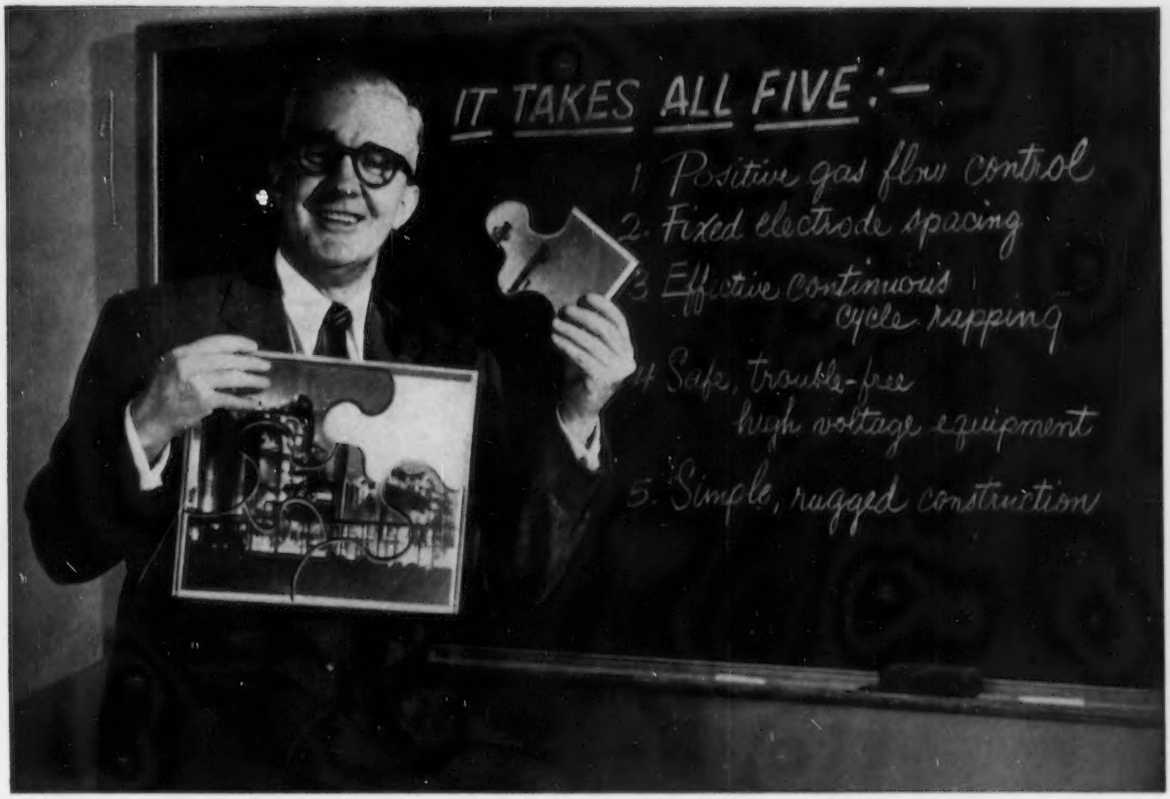
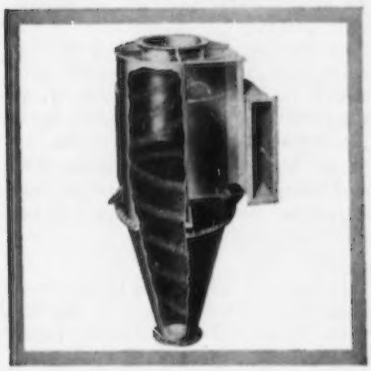
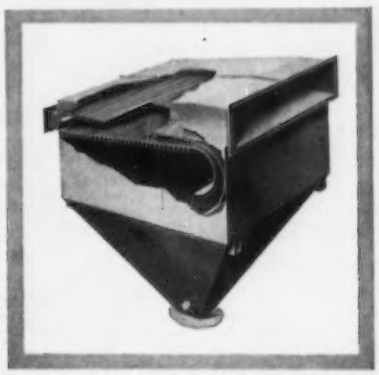
Buell 'SF' Electric Precipitators meet all 5 basic requirements for TOP EFFICIENCY


IT TAKES ALL FIVE:—
1. Positive gas flow control
2. Fixed electrode spacing
3. Effective continuous cycle rapping
4. Safe, trouble-free high voltage equipment
5. Simple, rugged construction

A slight deficiency of any single factor would be sufficient to impair the performance or service life of any dust recovery system. The constant top efficiency of Buell installations is the result of skillfully adjusting all five elements to best meet various operating conditions . . . provide consistent top efficiency.



Buell Cyclone Collectors are noted for their efficiency, too. Here are exclusive reasons why: shave-off design which harnesses back-flow and puts it to work . . . plus extra large diameter design to prevent "plugging."



Buell "LR" Fly Ash Collectors are ideal for low and high pressure boiler operations up to 2000 BHP, with either natural or mechanical draft. Check them for high efficiency, simple design, compactness, flexibility in layout.

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MECHANICAL ELECTRICAL *Experts at delivering Extra Efficiency in* **DUST COLLECTION SYSTEMS**

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A fine radiation detection instrument, like a work of art, can only be produced by master craftsmen. Each LA ROE Scintillation Detector is a craftsman product receiving individual care and attention by expert engineers.

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LA ROE is a pioneer in the field of scintillation detectors—founded by research scientists and engineers formerly associated with the Atomic and Radiation Physics Division of the National Bureau of Standards. LA ROE detectors are the product of experience born of extensive research in the field of radiation detection.

LA ROE does not make extravagant claims. It is said, and we sincerely believe that we make the finest radiation detectors available, and sell them at competitive prices. Before you invest, compare with the best, a LA ROE!

What LA ROE users say:

- ". . . We wish to inform you that your instrument has proved under actual field conditions to be an exceptionally fine piece of equipment. We find your instrument to be extremely sensitive yet you have accomplished through your design a stability of background not heretofore obtained from any other type . . . "
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- ". . . I just returned from Colorado Plateau yesterday. I inquired about and investigated the principal makes of the scintillators and the opinion expressed by the men in the field was that electronically nothing equalled the LA ROE instruments. I am sorry that I did not order sooner but I hesitated until I had a chance to ask the men flying them . . . "
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E&MJ's BUYERS' GUIDE Is Right Up-to-the-Minute

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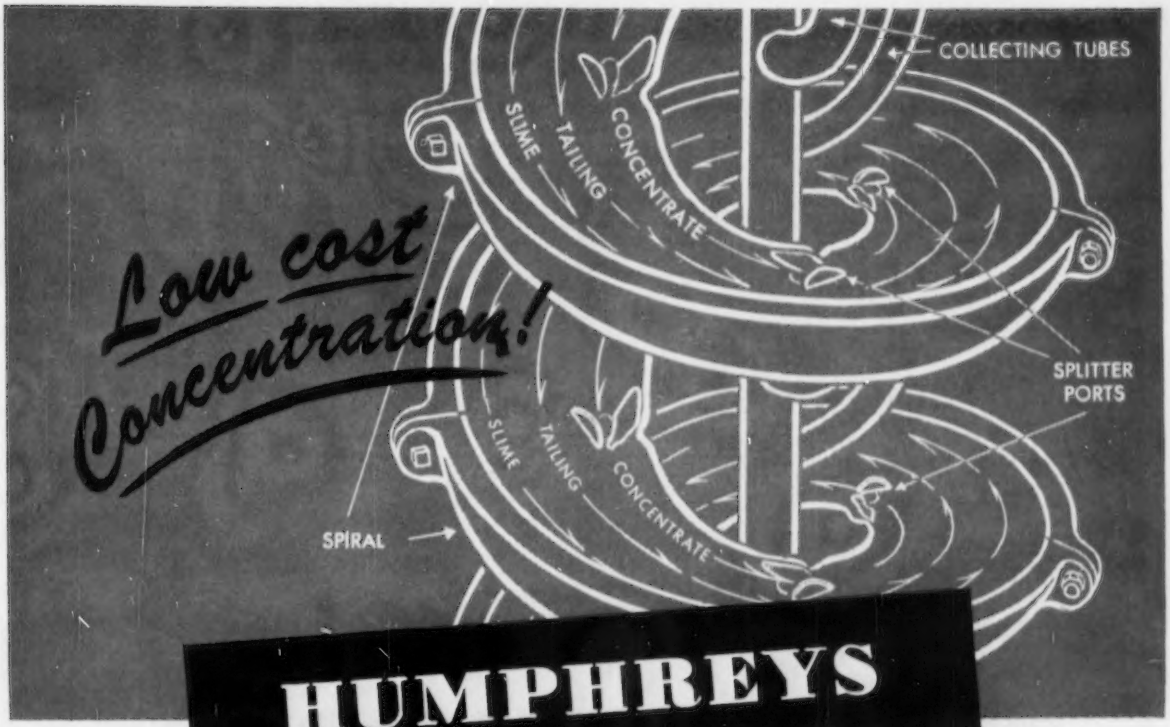

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Spiral Concentrator

LOW COST CONGENTRATION.
Humphreys spiral concentrators have successfully treated Hematite, Martite, Magnetite, Ilmenite, Zircon, Rutile, Monazite Sands, Phosphate Rock, Tungsten, Wolframite, Scheelite, Micas, Muscovite, Biotite, Lepidolite, Vermiculite, Native Copper, Chromite, Pyrite, Barite, Tantalite, Columbite, Talc and Anthracite Coal.

Throughout the world economy-minded mineral producers rely on Humphreys Spirals . . for low-cost concentration and increased production. These highly efficient concentrators are noted for economical installation, low-cost maintenance and dollar-saving operation . . . plus trouble-free performance over long periods of operation. No moving parts. Require very little floor space.

APPLICATIONS:

- Production of a concentrate and a tailing in a single rougher stage.
- Production of a bulk concentrate of several heavy minerals and a finished tailing.
- Scavenging the tailing from another process for the recovery of heavy minerals not amenable to the primary processes.
- Production of a finished concentrate, with a tailing to be treated by another process.

Write today for information on metallurgical tests of your ore samples for spiral treatment.

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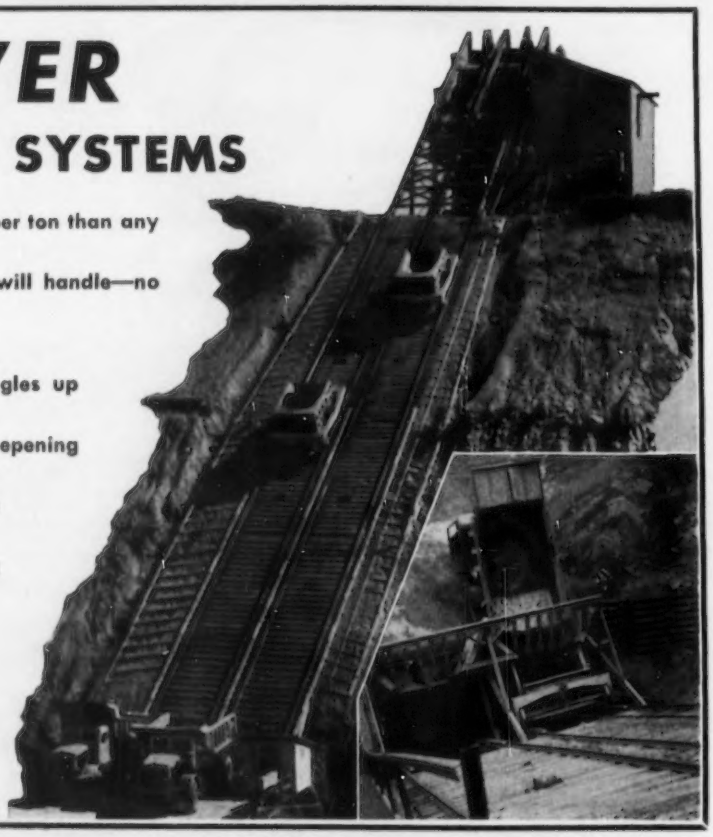
OPEN PIT SKIP SYSTEMS

- **Will elevate material at a lower cost per ton than any other system.**
- **Handle anything shovels and trucks will handle—no material too abrasive or blocky.**
- **Use only a few trucks in the pit.**
- **Track laid directly on pit wall at angles up to 45°.**
- **Simple extension of track follows deepening of pit.**
- **Load directly from trucks in pit. (See inset photo)**
- **Use multiple loading stations along trackway if desired.**

Skips of from 5 - 35 ton capacities available. Write for information.



NATIONAL IRON COMPANY
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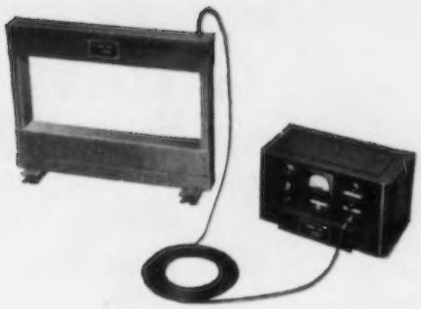
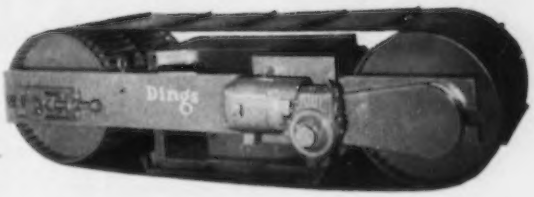


NEW DINGS METAL DETECTOR

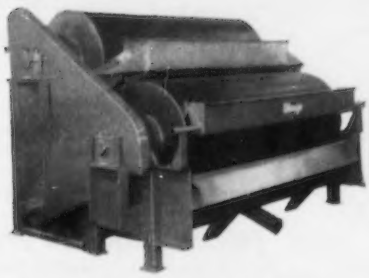
Now . . . a positive, low-cost method for protecting valuable processing machinery against tramp metal damage. This simple, easily installed Detector will detect the presence of all magnetic metals — as well as weakly magnetics such as manganese — even in extremely deep burdens. Completely self-contained, with 30 feet of cable for remote control.



DINGS RECTANGULAR SUSPENDED MAGNET

For pulling iron from fastest belts, deepest burdens, here's the mightiest member of Dings force — RM models available to pull iron through 30 inch air gap. New Dings RM uses less current, weighs less in proportion to strength — Compact design takes less room, dissipates heat faster.

Remove Tramp Iron and Reduce Processing Costs with these 4 efficient DINGS PRODUCTS



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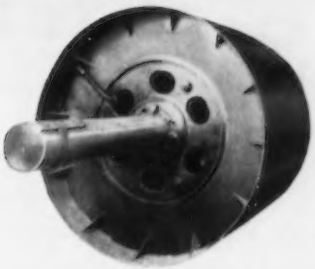
For maximum efficency and economy in all classes of heavy-media separation and direct concentration service, Dings offers a full line of wet drum magnetic separators to meet your specific requirements. Backed by over 50 years of specialized experience and proved performance.



DINGS MAGNETIC PULLEYS

Powerful, air cooled electro magnetic pulleys are ideal for conveyor belts with heavy burdens. Installed as head drive pulley, tramp iron is discharged automatically. Low operating cost, long life and maximum range characterize this workhorse of the Dings line.

Dings *non-electric, self-energized* Perma Pulley magnets are recommended where burden depths do not exceed 3".

Dings

DINGS MAGNETIC SEPARATOR CO.
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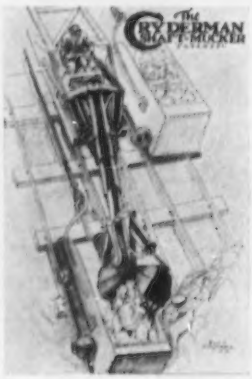
GM155

Vertical Machine (Clam Bucket)

Operated by one man, the air controlled clam-bucket and telescopic boom, like a human arm can reach any spot in the shaft bottom. Positive controlled crowding action, plus positive loading and positioning of the bucket, gives desired digging pressure at all times.

Incline Machine (Back-Hoe Type)

With its tremendous digging force and leverage, the Cryderman equipped with a back-hoe bucket is ideal for limited working height in inclined shafts. The unit is strong and tough, enabling it to take the terrific punishment of shaft mucking under all conditions.



Incline Machine (Clam Bucket)

With the same gimbal type bracket and telescopic boom, the Cryderman is easily adapted to inclined shafts. Seven air cylinders controlled by two levers, actuate multiple valves controlling the clam-bucket movement. An actual shoveling action is attained.

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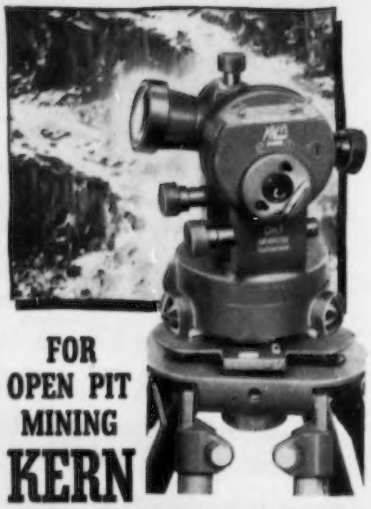
RIGHT for the JOB



FOR OPEN PIT MINING KERN DKI THEODOLITE

Down-to-fundamentals design ... made for portability, rugged use ... Precision results in simplest, quickest way.

Only 6 lbs. in weight, 7" high, including carrying case.

READINGS at a GLANCE

- Fast, effortless operation.
- Direct to 10', Estimation to 1'.
- Automatically gives arithmetic mean of two readings at opposite circle points

FOR UNDERGROUND OPERATION

- Illuminated Traverse Targets easily interchanged with instrument.
- Water and dust-proof.
- Exceptional clarity of optical system—50% brighter image through Kern AR coating.

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PROMPT, RELIABLE SERVICE
FACTORY TRAINED PERSONNEL
KERN and ONLY KERN
OFFERS YOU
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Dr. Henry WILD

Kern SWISS — *The FINEST in SURVEYING EQUIPMENT*

KERN INSTRUMENTS INC.
120 Grand St., White Plains, N.Y.

Here's the Most Complete BUYERS' GUIDE You Can Find!

The Buyers' Guide Section in this Guidebook is the most comprehensive listing of manufacturers available in the industry. Product listings are based on information obtained from all known manufacturers serving the field—a company-by-company check conducted by the E&MJ editors just for this 1956 edition.

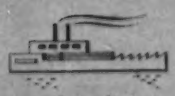
Manufacturers advertising in this issue appear in bold-faced type in the Buyers' Guide. You'll find more helpful product information in their advertisements.

E&MJ's MINING GUIDEBOOK AND BUYING DIRECTORY ISSUE is an established annual service for all E&MJ subscribers.

Kleenslot

WEDGE WIRE PREPARATION SCREENS

mining



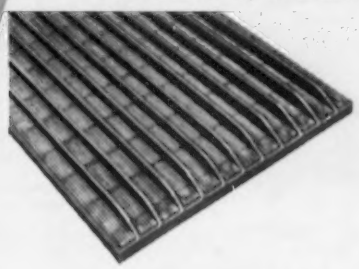
foods

chemicals

abrasives

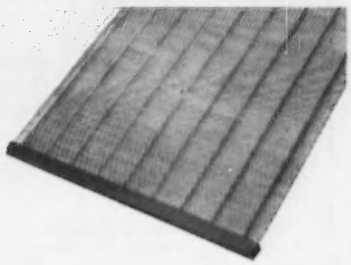
oil

FOR DEWATERING, SCREENING, WASHING, EXTRACTING, FILTERING or SIZING APPLICATIONS



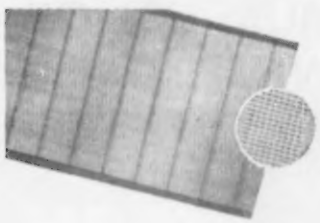
SCREEN GUARDS

A new innovation in the mining and industrial field. Particularly adaptable for use in flumes. The screen guard is built right into the screen and the vertical guard bars keep the larger lumps of material above the guard bars, permitting only the finer particles to pass over the screen. Special sizes can be furnished.



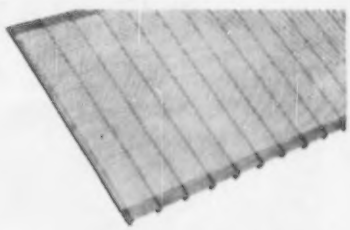
VIBRATOR SCREENS

They can be designed and adapted to fit any make of vibrator. You do not have to change your present machine to accommodate this screen. It is of quality construction and built to give maximum service. The rigid construction and method of installation prevents "whipping".



MARCEL-TYPE SCREENS

This screen is entirely different inasmuch as it is of a Marcel-type construction. It was designed for operations where slivers passing through are objectionable in the end product. This screen can be made in all sizes and shapes wherever applicable to higher and productive efficiencies. It gives long life and non-blinding operation.



ALUMINUM SCREENS

This aluminum screen has all of the attractive and sturdy features of many other metals. In addition, it offers flexing action that adds capacity and dewatering abilities which are almost unbelievable. No changes are necessary in the body of the screen to effect its installation.

NON-BLINDING — NON-CLOGGING - LONGER LIFE - MOST ECONOMICAL

The diagram at left shows all of the efficiency that can be furnished to you by KLEENSLOT Wedge Wire Preparation Screens, inasmuch as the wedge construction permits easy clearing. KLEENSLOT Wedge Wire Screens can be furnished in practically any type of metal. It costs nothing to obtain a Wedge Wire recommendation free of charge. Complete literature is available for the mining, oil, food, chemical and abrasives industry. There is a KLEENSLOT Wedge Wire Screen for every application.

WEDGE-WIRE CORPORATION

GAS STREET AND NICKEL PLATE R. R.
WELLINGTON, OHIO

POIDOMETERS for . . . .

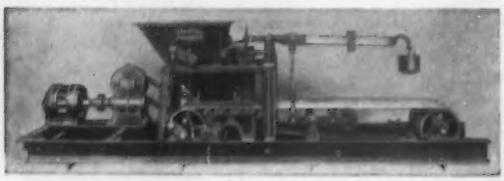
WEIGHING • CONVEYING • PROPORTIONING • BLENDING • FEEDING • MIXING

The Schaffer Poidometer is an accurate, durable machine for weighing, feeding and conveying raw materials used in mining, milling, smelting, refining and concentrating industries. Automatic and always dependable, it handles all crushed, granular and pulverized matter.

Proportioning by weight is a function to which the Poidometer is particularly well adapted. In a wide range of applications, batteries of Poidometers regulate and facilitate blending and mixing processes, at the same time keeping an accurate, centralized record of the amounts of materials handled.

SIZE		MAXIMUM CAPACITY*		Maximum Size of Cubes	Available With Motor Operated Gate
Belt Width	Length Scale Platform	Light Duty	Heavy Duty		
6"	2' 0"	2 Tons		Finely ground	No
10"	2' 6"	5 Tons		Finely ground	No
	4' 6" & 6' 0"		12 Tons	Finely ground	No
14"	2' 6"	8 Tons		½" Cubes	No
	4' 6" & 6' 0"		24 Tons	½" Cubes	No
20"	2' 6"	15 Tons		1½" Cubes	No
	4' 6" & 6' 0"		60 Tons	1½" Cubes	Yes
30"	4' 6" & 6' 0"		158 Tons	3" Cubes	Yes
36"	4' 6" & 6' 0"		220 Tons	4" Cubes	Yes
48"	4' 6" & 6' 0"		300 Tons	4½" Cubes	Yes

* Figured on material weighing 100 lbs. per cubic foot. Amount shown is capacity per hour.



THE AUTOMATIC FEEDER-WEIGHER CONVEYOR
Write for Catalog No. 4

MATERIALS HANDLED BY POIDOMETERS

Bauxite	Graphite	Phosphate Rock
Clay	Gravel	Potash Salts
Coal	Gypsum	Quartz
Copper Ore	Iron Ore	Salt
Copper Concentrates	Iron Scale	Sand
Copperas	Lead Ore	Sandstone
Dolomite	Lime Pebble	Seashells
Feldspar	Lime Hydrated	Stone
Ferric Sulphate	Lime Granular	Sulphur
Fullers Earth	Limestone	Zinc Oxide
	Manganese	

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P.O. Box #321

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New! WARN LOCKOMATIC HUBS

New Convenience with AUTOMATIC FREE-WHEELING 2-WHEEL DRIVE and AUTOMATIC 4-WHEEL DRIVE forward and reverse AS YOU SHIFT!

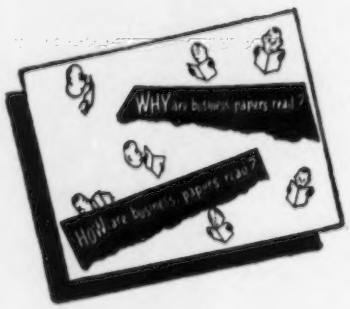
Plus "Locking" controls for 4-wheel drive engine braking control safety.

Over 75,000 Warn Hubs in use

Stop front-end drag in 2 w. d.!

Your 4-wheel drive with Warn Hubs is the *only* vehicle you can own that has *all* the advantages and usefulness of *both* a 2 and 4-wheel drive. It has pep, speed, handling ease, economy on the highway in 2-wheel drive—and full-power traction in the rough going in 4-wheel drive. You save on equipment and operation. You get maximum use of your vehicle. Your dealer has Warn Lock-o-matic or Locking Hubs. See him or write us. Willys models sold exclusively by Willys dealers.

WARN MFG. CO. Riverton Box 6064-EM6 Seattle 88, Washington



A copy of this quick-reading, 8-page booklet is yours for the asking. It contains many facts on the benefits derived from your business paper and tips on how to read more profitably. Write for the "WHY and HOW booklet."

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Exide INDUSTRIAL DIVISION, The Electric Storage Battery Company, Philadelphia 2, Pa.

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Exide®-Ironclad® MINING BATTERIES

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HIGH AVAILABILITY OF EQUIPMENT—Ironclad dependability prevents unscheduled down time

LOW OPERATING COSTS—because of their high electrical efficiency

LOW DEPRECIATION COSTS—because of their proved long service life

JOB-RATED EQUIPMENT—with their wide range of capacities and sizes for every task

SAFE HAULAGE—there are no hazards of fire, fumes, noise, power failure associated with Exide-Ironclads

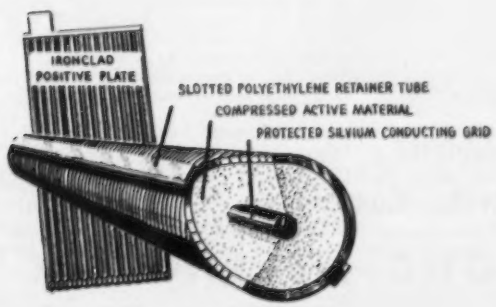
NEW, EXCLUSIVE EXIDE-IRONCLAD FEATURES

New Alloys—Silvium®, the latest development in grid alloys, prevents wear of the positive grid spines . . . assures higher sustained power for longer, useful working life.

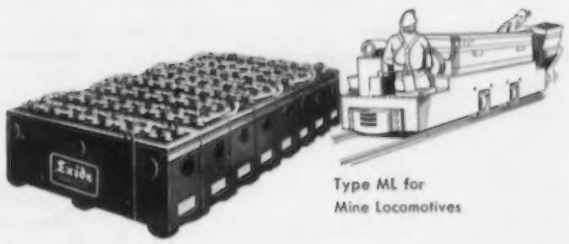
New Plastics—non-oxidizing polyethylene tubes improve battery performance and provide greater capacity in the same space.

Unique Positive Plates—the unique polyethylene slotted tubes inside an Ironclad keep active material in firm contact with the Silvium conducting grids of the positive plates . . . this grid protection lengthens the life of the battery. Slotted tubes expose more active material to the electrolyte . . . for greater power. Fine tube slots hold material in contact with grid longer. Result: The Ironclad battery's ability to furnish dependable power for a longer time—at lowest cost.

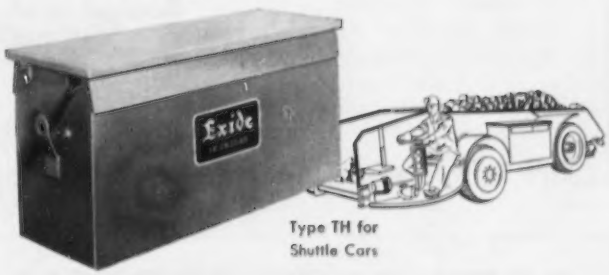
Other features include improved negative plates, new sealing compound, shock-proof molded container, unbreakable plastic vent plugs.



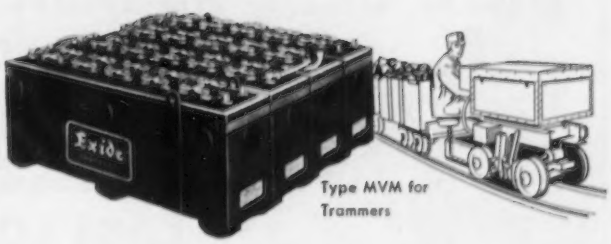
A FEW OF MANY EXIDE-IRONCLAD TYPES



Type ML for
Mine Locomotives



Type TH for
Shuttle Cars



Type MVM for
Trammers

Let Exide help solve your mining battery problems. Call the Exide sales office listed below. Write for specification sheets and Form 1982, a manual on maintaining motive power batteries.

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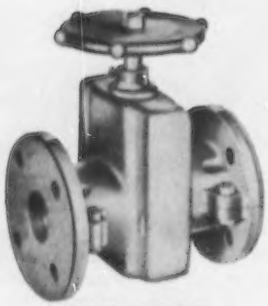
BOTH DEFY ABRASION and CORROSION

BOTH MADE WITH LINATEX



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Against the attack of abrasive and corrosive solutions, liners made of Linatex last longer. Double acting jaw closure gives streamlined flow in all positions. Metal body prevents spillage from worn tube. Inexpensive tube easily replaced.
Available in sizes: 1 inch through 8 inches.
Please write for further information.

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It has been proved that parts made with LINATEX outwear any OTHER material in the world because nothing resists corrosion and abrasion like LINATEX. That's why it will pay you to be sure LINATEX protects your equipment.

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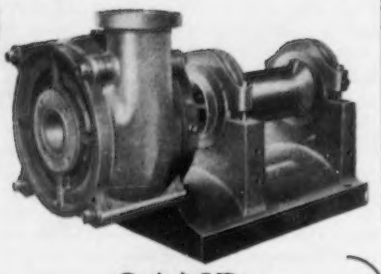
Corporation of America



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All wearing parts are covered with long lasting, abrasion resistant Linatex.
If you are responsible for an efficient pumping operation at your plant, write for further information on the LINATEX Pump. Let us convince you that Linatex Sand Pumps will outwear any other sand pumps in the world.
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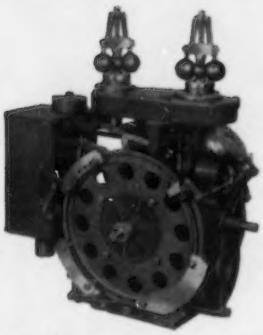
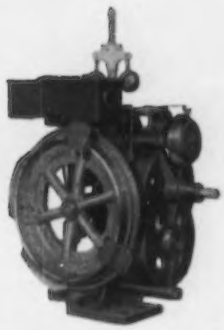
Automatic Safety Equipment for Mine Hoists, Hoist Recorders and Recording Tachometers, Brake Engines, Pressure Units, Aridifiers for Air Lines, and other Engineering Specialties

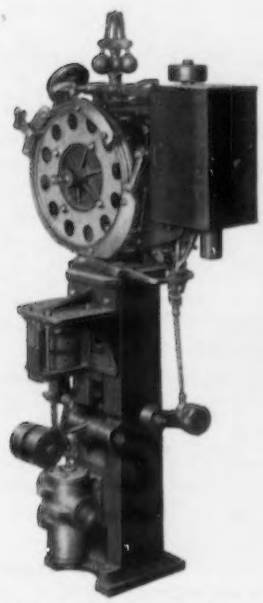


A MODEL C LILLY HOIST CONTROLLER with Duplex Governors. Model C Controllers are particularly suited to large and fast hoists. (See Catalog C-44)

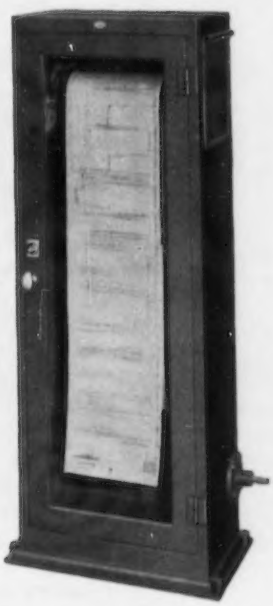
A SIMPLEX HOIST CONTROLLER equipped with Depth Indicator and mounted on a Weight Unit with Regulating Cylinder for operating the brakes of small hoists. These units are best suited to small or relatively low speed hoists. (See Catalog S-46)



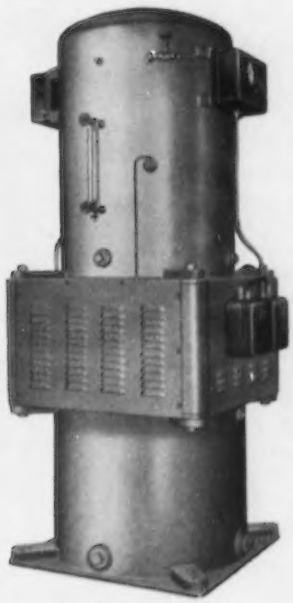
A MODEL D LILLY HOIST CONTROLLER assembled left hand. Model D Controllers are particularly suited to small or medium size hoists. (See Catalog D-44)



A MODEL C LILLY HOIST CONTROLLER with Single Governor, mounted on a Solenoid Valve Unit with Automatic Brake Regulator for hydraulically operated brakes.



LOGAN HOIST RECORDER for recording all movements and delays of the hoist, and to provide a graphic picture of the manner in which it is operated. (See Catalog 447)



LOGAN AUTOMATIC HYDRAULIC PRESSURE UNITS, for operating hydraulic brakes. Made in four standard sizes, 20, 30, 40 and 70 gallons per minute. (See Catalog 3-47)

A MODEL D LILLY CONTROLLER, mounted on Weight Unit with Regulating Cylinder for operating the brakes of small hoists.

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Tee-Cee One-Pass carbide drill bits

COST HALF THE PRICE OF OTHER CARBIDES . . . HAVE CUT DRILLING COSTS UP TO 75%

HERE'S THE PROOF

RESULTS OF TESTS IN CANADIAN MINES *

MINE TESTS	FORMER COST PER FT. DRILLED WITH OTHER CARBIDES	COST PER FOOT WITH TEE-CEE ONE-PASS CARBIDE BITS	COST SAVINGS PER FOOT	PERCENTAGE SAVING PER FOOT	SAVING ON EVERY 100,000 FT. OF DRILLING
"A"	8.2¢	2.06¢	6.14¢	74.87%	$6,140.
"B"	11.3¢	5.07¢	6.23¢	55.13%	$6,230.
"C"	8.0¢	7.15¢	.85¢	10.51%	$ 850.
"D"	3.2¢	2.7 ¢	.5 ¢	15.6 %	$ 500.
"E"	4.5¢	2.0 ¢	2.5 ¢	55.5 %	$2,500.
"F"	9.6¢	6.3 ¢	3.3 ¢	34.37%	$3,300.

The revolutionary new "Tee-Cee One-Pass" Carbide Drill bit costs less than half the price of other carbides—you drill it to destruction, then throw it away. Tested and proven in 35 Canadian mines, it cuts costs in almost every case . . . up to 75% in one test. The "Tee-Cee One-Pass" carbide bit earns additional savings, too. It eliminates time wasted in transporting worn bits to the surface . . . does away with the cost of grinding time and equipment. Test this bit on your own operation. Write to: Thompson Products Limited, Mining Division, St. Catharines, Ontario, Canada.

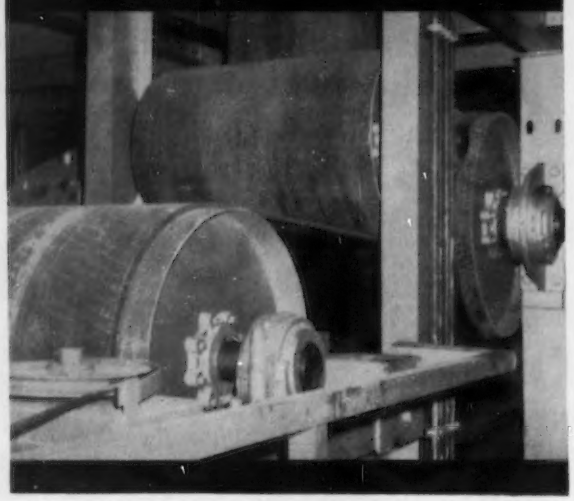
New "Tee-Cee One-Pass" Carbide Bit can be used with existing steels. Simply cut off solid carbide tip or thread and forge, grind or machine your steels to an 11 degree taper. New brass shim makes fitting and knock-off easier.

LIDDICOAT Detachable Drill Bits by

Thompson Products

THOMPSON PRODUCTS LTD., ST. CATHARINES, ONTARIO

TURNING POINTS—



Wherever conveyor belts *turn over*, industry *turns to* the American Pulley Company. From pit or mine to crushing . . . to processing . . . in and out of storage . . . a high portion of recent installations are equipped with American Conveyor Pulleys.

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BUILT TO LAST . . . by controlled precision methods . . . by pulley specialists with over sixty years of experience.

When you install new conveyors or modernize existing ones, turn to American for Conveyor Pulleys—Built for the Belt . . . over 400 standard sizes.

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The American Pulley Company

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PLYMOUTH DIESEL

MINE-O-MOTIVE

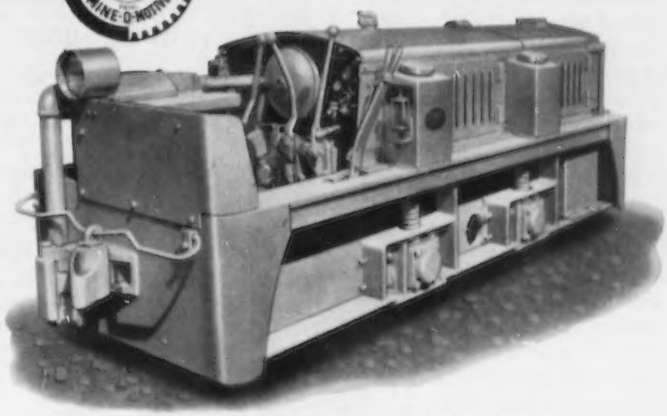
Mine Locomotives 3 to 12 Tons

Engineered expressly for

YOUR LOCOMOTIVE HAULAGE

in Today's modern mining operations

You will find these rugged locomotives performing the toughest hauling jobs in mines and tunnels everywhere. Stamina, stability—ECONOMY in performance, SAFETY in operation—and extra years of trouble-free operation—are ENGINEERED in the design and construction of the Mine-O-Motive series. Controls are convenient, simple, safe. Visibility is excellent. And the Diesel-powered models shown have the famous Torqomotive* Drive for easy starting and smooth operation. They supplement Plymouth gasoline, Diesel and Diesel-electric models which have served all industry since 1914—and with lowest ton-mile costs in the field.



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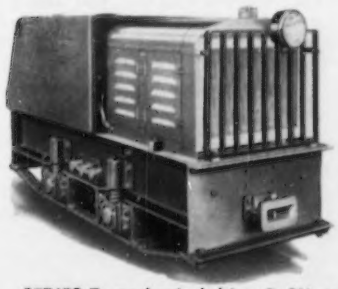

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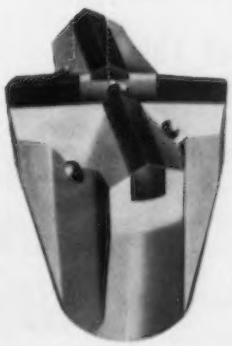
Style PC Bits, Cross type, have inserts set 90° apart. The four cutting edges allow these bits to operate without wedging in fissured or ravelly formations.

Style PX



The "X" Bits, Style PX, also have four cutting blades. In this style, however, they are not spaced 90° apart. The blades of these bits form the pattern of two intersecting but non-perpendicular lines. This pattern eliminates rifling and produces the uniformly round hole required by certain blasting devices and techniques.

B-5901

SPECIFICATIONS

Bit Size Inches	Thread* Types	Chisel Bit Catalog No.	Cross Bit Catalog No.	X Bit Catalog No.
1¼	S (112)	PAS-1¼	PCS-1¼	
	A (114)	**PAA-1¼**	PCA-1¼	
1⅜	A (114)	**PAA-1⅜**	PCA-1⅜	
	113	PA113-1⅜	**PC113-1⅜**	
1½	F (114)	**PAF-1½**	**PCF-1½**	
	113	PA113-1½	PC113-1½	
1⅝	F (114)	PAF-1⅝	PCF-1⅝	
	H (116)	**PAH-1⅝**	**PCH-1⅝**	
	115	PA115-1⅝	**PC115-1⅝**	
1¾	F (114)	PAF-1¾	PCF-1¾	
	H (116)	**PAH-1¾**	**PCH-1¾**	
	115	PA115-1¾	PC115-1¾	
1⅞	H (116)	**PAH-1⅞**	**PCH-1⅞**	
2	H (116)	**PAH-2**	**PCH-2**	
	D (119)		**PCD-2**	
	200		PC200-2	
2⅛	D (119)		**PCD-2⅛**	
	200		PC200-2⅛	
2¼	D (119)	PAD-2¼	**PCD-2¼**	
	200		PC200-2¼	
	400		PC400-2¼	
2⅜	D (119)		**PCD-2⅜**	
	200		PC200-2⅜	
	400		PC400-2⅜	
	121		PC121-2⅜	
2½	D (119)	PAD-2½	**PCD-2½**	
	200		PC200-2½	
	400		PC400-2½	
	121		**PC121-2½**	
2¾	D (119)		PCD-2¾	
	400		PC400-2¾	
	121		**PC121-2¾**	
3	400		PC400-3	PX400-3
	121		**PC121-3**	PX121-3
	K		PCK-3	PXK-3
	600	PA600-3	**PC600-3**	**PX600-3**
3¼	K		PCK-3¼	PXK-3¼
	600		PC600-3¼	PX600-3¼
3½	K		PCK-3½	PXK-3½
	600		**PC600-3½**	**PX600-3½**
4	K		PCK-4	PXK-4
	600		PC600-4	PX600-4
4½	K		PCK-4½	PXK-4½
	600		PC600-4½	PX600-4½

*Numbers in parentheses show interchangeable thread styles.

Note: Bold face indicates sizes normally stocked. Light face shows items available on order. Other suitable combinations of bit diameter and standard thread styles can be supplied.

LEFT: *Weighing a car in motion at Seven Islands.* BELOW: *Typical control and printing units at Seaboard's Hamlet yard.*

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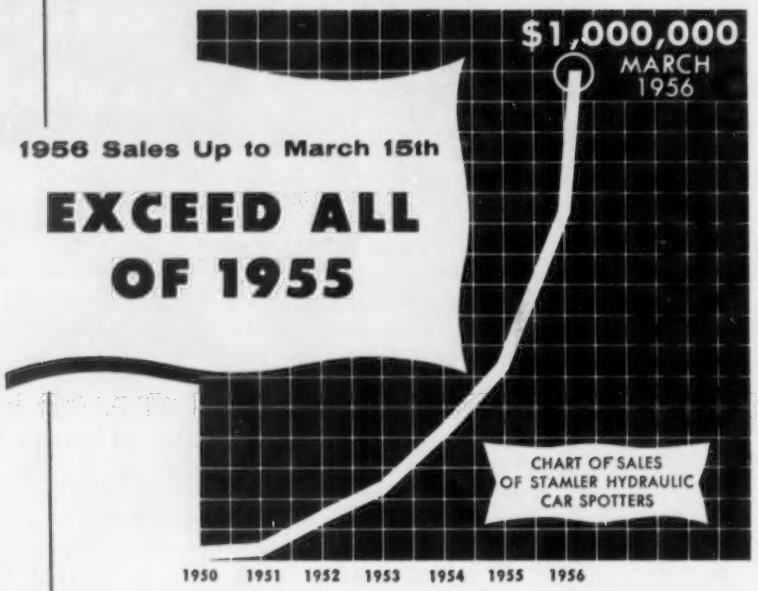

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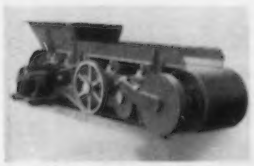
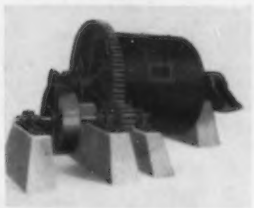


MORSE SILENT "VARI-STROKE" ORE FEEDER



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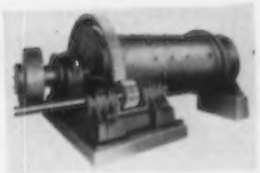
MORSE-"JETAIR" FLOTATION CELLS

MORSE CONDITIONERS

MORSE ROD MILLS



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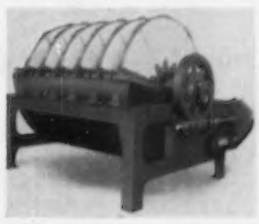

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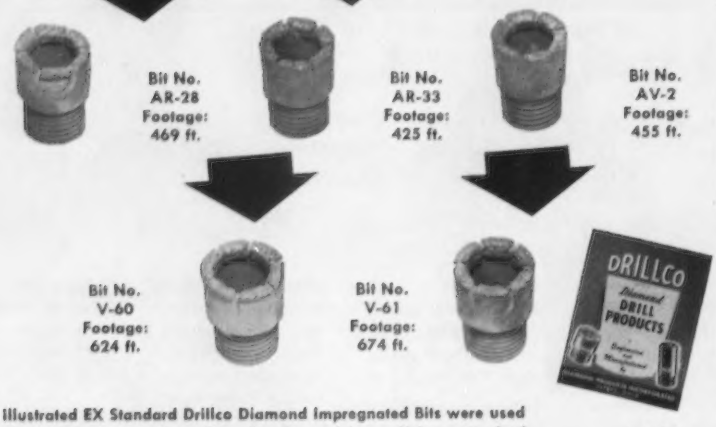
Bit No. AR-28 Footage: 469 ft.
Bit No. AR-33 Footage: 425 ft.
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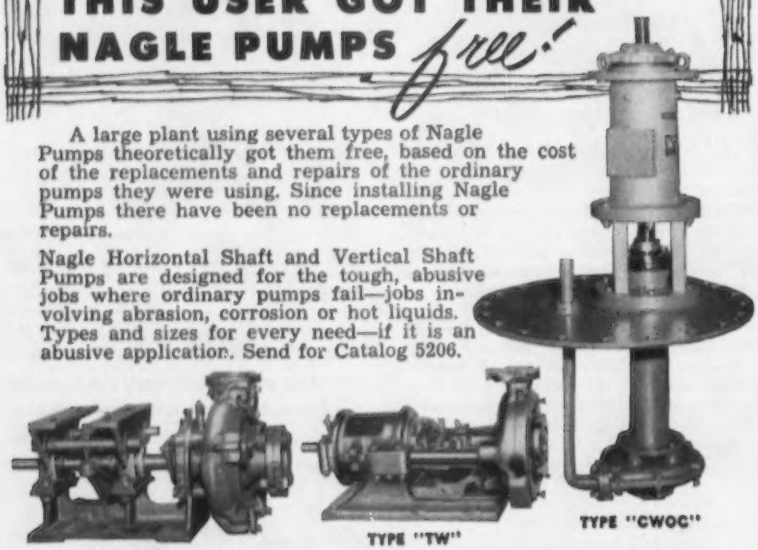

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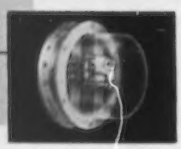

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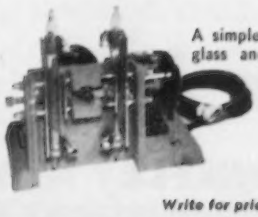

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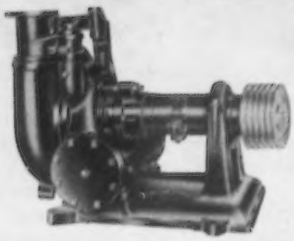

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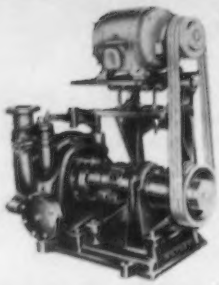

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ENGINEERING AND MINING JOURNAL

1956

BUYERS' GUIDE

WHO SUPPLIES IT? . . . Section 1 of this Buyers' Guide gives you an alphabetical list of products and services used in the metal and non-metallic mining industry together with the names of those who furnish them. We have tried to include only primary manufacturers especially interested in the mining industry. They will willingly act on all your inquiries including reference to local distributors and suppliers. Those in bold type have a special message for you in this Guidebook; the page number of their ad is given with their address in the second section.

WHERE ARE THEY? . . . Section 2 of this Buyers' Guide gives you the addresses of all companies listed in the first section. They are arranged alphabetically. Advertisers are shown in bold type, followed by the page number of their ad. You will find the ad contains more information on a product or service designed to help you cut costs and increase production.

SECTION 1: PRODUCTS AND SERVICES

ABRASIVES

American Optical Co.
Bay State Abrasive Products Co.
Calebaugh Self Lubricating Carbon Co.
Carborundum Co.
Chicago Wheel & Mfg. Co.
Clipper Mfg. Co.
Continental Mineral Processing Co.
DeWalt, Inc.
Exolon Co.
Hoffman Brothers Drilling & Mfg. Co.
Ideal Industries, Inc.
Johns-Manville
Macklin Co.
Marathon Coal Bit Co.
MacLeod Co.
Minnesota Mining & Mfg. Co.
Norton Co.
Patrick, Inc., R. S.
Pettinos, Inc., George F.
Precision Grinding Wheel Co., Inc.
Shwayder Chemical Metallurgy Corp.
Simonds Worden White Co.
Sly Mfg. Co., W. W.
Snyder Mine & Chemical Lab.
Thor Power Tool Co.
Waltham Grinding Wheel Co.
Wheelabrator Corp.

ACETYLENE GENERATORS

Air Reduction Co., Inc.
National Cylinder Gas Co.
Sight Feed Generator Co.
Southern Oxygen Co.
Union Carbide & Carbon Corp.
Linde Air Products Co. Div.

AERATORS

Acme Tank Mfg. Co.
American Water Softener Co.
American Well Works
Arrow Tank Co.
Bin-Dicator Co.
Booth Co.
Carter Co., Ralph B.
Drullard Co., Howard
Infilco, Inc.
Jeffrey Mfg. Co.
Johnson Co., C. S.
Penberthy Injector Co.
Permutit Co.
Simplicity Engineering Co.
U. S. Hoffman Machinery Corp.
Air Appliance Div.
Western Machinery Co.

AERIAL EXPLORATION SERVICE—See Exploration

AERIAL TRAMWAYS & CABLEWAYS

American Hoist & Derrick Co.
Flory Mfg. Co., S.
Link-Belt Co.
Neal Machinery Co., H. T.
Riblet Tramway Co.
Sauerman Bros., Inc.
Stearns Roger Mfg. Co.
Superior-Lidgerwood-Mundy Corp.
U. S. Steel Corp.
Columbia-Geneva Steel Div.
Willamette Iron & Steel Co.
Yara Engineering Corp.
Interstate Equipment Div.

AFTERCOOLERS—see Coolers

AGGLOMERATING EQUIPMENT & SUPPLIES—See Nodulizing Equipment; Sintering Equipment; or Water Treatment Chemicals

AGITATORS—also see Flotation Machines

Bethlehem Foundry & Machine Co.
Blaw-Knox Co.
Carter Co., Ralph B.
Christian Engineers, J. D.
Denver Equipment Co.
Dorr Oliver, Inc.
Dravo Corp.
Eimco Corp.
Gallagher Co.
General American Transportation Corp.
Hardinge Co., Inc.
Infilco, Inc.
Jeffrey Mfg. Co.
Majac Inc.
Morse Bros. Machinery Co.
Ogden Iron Works
Patterson Foundry & Machine Co.
Process Engineering, Inc.
Smidth & Co., F. L.
Syntron Co.
Union Iron Works
Western Machinery Co.

AIRCRAFT

Beech Aircraft Corp.
Bell Aircraft Corp.
Cessna Aircraft Co.
Hiller Helicopters
Sikorsky Division
United Aircraft Co.

AIR COMPRESSORS—see Compressors

AIR COOLERS—see Coolers

AIR LINE OILERS

Atlas Copco Eastern, Inc.
Atlas Copco Pacific, Inc.
Chicago Pneumatic Tool Co.
Davey Compressor Co.
Drullard Co., Howard
Gardner Denver Co.
Thor Power Tool Co.
Victor Equipment Co.
Westinghouse Air Brake Co.
Westinghouse Air Brake Co.
Cleveland Rock Drill Plant, Le Roi Div.
Wilkerson Corp.

AIR MOTORS

Atlas Copco Pacific Inc.
Chicago Pneumatic Tool Co.
Eimco Corp.
Gardner Denver Co.
Holman Bros. (Canada), Ltd.
Ingersoll-Rand Co.
Joy Mfg. Co.
McCulloch Motors Corp.
Thor Power Tool Co.
Westinghouse Air Brake Co.
Cleveland Rock Drill Plant, Le Roi Div.

AIR PREHEATERS—also see Heaters

American Blower Corp.
(Div. American-Standard)
Braun & Co., C. F.
Condenser Service & Engineering Co.
Erie City Iron Works
Keeler Co., E.
Kewanee-Ross Corp.
Mohr Mfg. Co.
Salem-Brosius, Inc.
Springfield Boiler Co.
Wickes Boiler Co. Div.
Wickes Corp.

AIR RECEIVERS—also see Tanks

B-I-P Industries
Builders-Providence Div.

Chattanooga Boiler & Tank Co.
Chicago Pneumatic Tool Co.
Condenser Service & Engineering Co.
Curtis Manufacturing Co.
Davey Compressor Co.
Drullard Co., Howard
Ingersoll-Rand Co.
Joy Mfg. Co.
Kellogg Co., M. W.
Pennsylvania Pump & Compressor Co.
Union Iron Works
Vogt Machine Co., Henry
Westinghouse Air Brake Co.
Westinghouse Air Brake Co.
Ind. Products Div.
Wickes Boiler Co. Div.
Wickes Corp.
Willamette Iron & Steel Co.
Worthington Corp.

AMALGAMATORS—see Separators, Amalgamating

AMMETERS & VOLTMETERS—see Meters, Electricity

ANEMOMETERS—see Meters, Fluid

ARCH PLATES—see Mine Supports

ARRESTERS, LIGHTNING

Electric Service Mfg. Co.
General Electric Co.
Apparatus Sales Div.
Graybar Elec. Co., Inc.
International General Electric Co.
Line Material Co.
Ohio Brass Co.
Superior Carbon Products, Inc.
Westinghouse Electric Corp.

BAG FILLING MACHINES

Bemis Bros. Bag Co.
Chattanooga Boiler & Tank Co.
Consolidated Packaging Machinery Corp.
Food Machinery & Chemical Corp.
Packing Equipment Div.
Fulton Bag & Cotton Mills
Bag Div.
Savage Co., W. J.

BAGS, PAPER, FABRIC & PLASTIC—also see Blasting Bags

Albany Felt Co.
Bemis Bros. Bag Co.
Central Mine Supply Co.
Chase Bag Co.
Daniels Co. Contractors, Inc.
Equitable Paper Bag Co., Inc.
Fulton Bag & Cotton Mills
Bag Div.
International Paper Co.
Knapp Mills, Inc.
Kraft Bag Corp.
Pendleton Woolen Mills
Plummer Mfg. Co., W. A.
Raymond Bag Corp.
St. Regis Paper Co.
Tamping Bag Co.
Union Bag & Paper Corp.
Visking Corp.
Plastics Div.

BALL MILLS—see Mills, Ball

BALLS, GRINDING—see Mill Balls

BATTERIES, ELECTRIC, DRY & STORAGE

Auto-Lite Battery Corp.
Bowers Battery & Spark Plug Co.
Bright Star Battery Co.
Burgess Battery Co.
C & D Batteries, Inc.
Compton, Inc.
Continental Battery Mfg. Corp.
Edison Thomas A., Inc.
Exide Industrial Div.
Electric Storage Battery Co.
Gates Rubber Co.
General Dry Batteries Co. Div.
P. R. Mallory & Co., Inc.
Goodrich Co., B. F.
Truck & Bus Tire Dept.
Gould-National Batteries, Inc.
Graybar Elec. Co., Inc.
K. W. Battery Co.
National Mine Service Co.
Nife, Inc.
Phillips Petroleum Co.
Ray-O-Vac Co.
Yardney Electric Corp.

BATTERY CHARGERS

Automatic Electric Co.
Bowers Battery & Spark Plug Co.
Electro Products Laboratories
General Electric Co.
Apparatus Sales Div.
General Nuclear Corp.
Goodrich Co., B. F.
Truck & Bus Tire Dept.
Gould-National Batteries, Inc.
Graybar Elec. Co., Inc.
Hertner Electric Co.
Hobart Bros. Co.
Ideal Electric & Mfg. Co.
International General Electric Co.
Ironton Engine Co.
K. W. Battery Co.
Knapp, Inc.
Kurz & Root Co.
Lincoln Electric Co.
Mancha Storage Battery Locomotive Div., Goodman Mfg. Co.
Onan & Sons, Inc., D. W.
Quick Charge, Inc.
Syntron Co.
Ward Leonard Electric Co.
Westinghouse Electric Corp.

BATTERY TRANSFER RACKS

Gould-National Batteries, Inc.
Mancha Storage Battery Locomotive Div., Goodman Mfg. Co.

BEARING HANGERS, JOURNAL BOXES & PILLOW BLOCKS

Ahlberg Bearing Co.
Bodinson Manufacturing Co., Inc.
Card Iron Works, C. S.
Chain Belt Co.
Chicago Pulley & Shafting Co.
Christian Engineers, J. D.
Connellsville Mfg. & Mine Supply Co.
Continental Gin Co.
Industrial Div.
Cooper Split Roller Bearing Corp.
Dodge Mfg. Corp.
Flood City Brass & Elec. Co.
Helmick Foundry-Machine Co.
Hewitt-Robins, Inc.
Holmes & Bros., Inc., Robert
Imperial Cantrell Mfg. Co.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Link-Belt Co.
Maddox Foundry & Machine Works, Inc.
McNally Pittsburg Mfg. Corp.
Phillips Corp.
SKF Industries, Inc.
Transall, Inc.
United American Metals Corp.
West Virginia Armature Co.
Wood's Sons Co., T. B.

BEARING METAL

American Brake Shoe Co.
American Brass Co.
American Crucible Products Co.
American Smelting & Refining Co.
Belmont Smelting & Refining Works, Inc.
Bohn Aluminum & Brass Corp.
Bunting Brass & Bronze Co.
Cadman Mfg. Co., A. W.
Chase Brass & Copper Co.
Chicago Pulley & Shafting Co.
Dixon Valve & Coupling Co.
Federal-Mogul Corp.
Hewitt Metals Corp.
Johnson Bronze Co.
Keystone Carbon Co.
Lumen Bearing Co.
Magnolia Metal Co.
Mueller Brass Co.
National Lead Co.
Olds Alloy Co.
Phosphor Bronze Corp.
Ryerson & Son, Inc., Joseph T.
Saginaw Bearing Co.
Seymour Mfg. Co.
Torrington Co.
Bantam Bearings Div.
United American Metals Corp.
United States Graphite Co. Div.
Wickes Corp.
West Virginia Armature Co.
Williams & Son, E. A.

BEARINGS, BALL

Aetna Ball & Roller Bearing Co. Div.
Parkersburg-Aetna Corp.
Ahlberg Bearing Co.
American Smelting & Refining Co.
Chicago Pulley & Shafting Co.
Dodge Mfg. Corp.
Dominion Engineering Co., Ltd.
Fafnir Bearing Co.
Federal Bearings Co., Inc.
Federal-Mogul Corp.
General Motor Corp.
New Departure Div.
Gibraltar Equipment & Mfg. Co.
Gwilliam Co.
Hales Co., W. M.
Kaydon Engineering Corp.
Link-Belt Co.
Marlin-Rockwell Corp.
McNally Pittsburg Mfg. Corp.
Nice Ball Bearing Co.
Norma-Hoffmann Bearings Corp.
Sanford-Day Iron Works, Inc.
Schatz Mfg. Co.
SKF Industries, Inc.
Split Ballbearing Corp.
Stephens-Adamson Mfg. Co.
Torrington Co.
Torrington Co.
Bantam Bearings Div.
Wood's Sons Co., T. B.

BEARINGS, NEEDLE

Chicago Pulley & Shafting Co.
General Motors Corp.
Hyatt Bearings Div.
Hales Co., W. M.
Orange Roller Bearing Co., Inc.
Torrington Co.
Torrington Co.
Bantam Bearings Div.

BEARINGS, ROLLER

Aetna Ball & Roller Bearing Co. Div.
Parkersburg-Aetna Corp.
Bower Bearings Div.
Federal-Mogul-Bower Bearings, Inc.
Bower Roller Bearing Co.
Chain Belt Co.
Chain Belt Co.
Shafer Bearing Div.
Chicago Pulley & Shafting Co.
Dodge Mfg. Corp.
Enterprise Wheel & Car Corp.
Gibraltar Equipment & Mfg. Co.
Gwilliam Co.
Hales Co., W. M.
Kaydon Engineering Corp.
Link-Belt Co.
Marlin-Rockwell Corp.
McGill Mfg. Co., Inc.
McNally Pittsburg Mfg. Corp.
Norma-Hoffman Bearings Corp.
Orange Roller Bearing Co., Inc.
Roller Bearing Co. of America
Rollway Bearing Co., Inc.
Sanford-Day Iron Works, Inc.
SKF Industries, Inc.
Split Ballbearing Corp.
Timken Roller Bearing Co.
Torrington Co.
Torrington Co.
Bantam Bearings Div.
Tyson Bearing Corp.
Subsidiary of SKF Industries, Inc.
United American Metals Corp.

BEARINGS, SLEEVE

American Brake Shoe Co.
American Crucible Products Co.
American-Marsh Pumps, Inc.
Bartlett & Snow Co., C. O.
Bunting Brass & Bronze Co.
Carbone Corp.
Chicago Pulley & Shafting Co.
Dodge Mfg. Corp.
Federal-Mogul Corp.
Flood City Brass & Elec. Co.
Gatke Corp.
General Motors Corp.
Allison Div.
Imperial Cantrell Mfg. Co.
Johnson Bronze Co.
Keystone Carbon Co.
Link-Belt Co.
Magnolia Metal Co.
McNally Pittsburg Mfg. Corp.
Olds Alloy Co.
Saginaw Bearing Co.
Sanford-Day Iron Works, Inc.
United American Metals Corp.
West Virginia Armature Co.

BELT DRESSING

Chicago Belting Div.
Chicago-Allis Mfg. Corp.
Chicago Pulley & Shafting Co.
Cling-Surface Co.
Dixon Crucible Co., Joseph
Goodrich Industrial Products Co., B. F.
Graton & Knight Co.
Hewitt-Robins, Inc.
Johnson Belting Co.
Keystone Lubricating Co.
Missouri Belting Co.
Philadelphia Belting Co.
Raniville Co., F.
Rhoads & Son, J. E.
Schieren Co., Charles A.
Ton-Tex Corp.
Webb Belting & Supply Co.
Williams, I. B. & Sons

BELTS, CONVEYOR—see Conveyor Belting

BELTS, FLAT POWER TRANSMISSION

American Rubber Mfg. Co.
Boston Woven Hose & Rubber Co.
Carlyle Rubber Co.
Chicago Belting Div.
Chicago-Allis Mfg. Corp.
Chicago Pulley & Shafting Co.
Christian Engineers, J. D.
Cincinnati Rubber Mfg. Co.
Dick Co., R. & J.
Fisher Leather Belting Co., Inc.
Gates Rubber Co.
Gilmer Co., L. H.
Goodall Rubber Co.
Goodrich Co., B. F.
Flat Belting
Goodrich Industrial Products Co., B. F.
Goodrich Co., B. F.
Truck & Bus Tire Dept.
Goodyear Tire & Rubber Co.
Goodyear Tire & Rubber Co.
Industrial Products
Graton & Knight Co.
Hamilton Rubber Mfg. Corp.
Hewitt-Robins, Inc.
Houghton & Co., E. F.
Johnson Belting Co.
Missouri Belting Co.
New York Belting & Packing Co.
New York Rubber Corp.
Philadelphia Belting Co.
Porter Co., Inc., H. K.
Quaker Pioneer Rubber Div.
Porter Co., H. K.
Quaker Rubber Co. Div.
Raniville Co., F.
Raybestos-Manhattan, Inc.
Manhattan Rubber Div.
Republic Rubber Div.
Lee Rubber & Tire Corp.
Rhoads & Son, J. E.
Scandinavia Belting Co.
Schieren Co., Charles A.
Sikes Co., S. R.
Snyder & Son, Inc., M. L.
Thermoid Co.
Industrial Div.
Thor Power Tool Co.
Ton-Tex Corp.
Webb Belting & Supply Co.
Williams, I. B. & Sons

BELTS, "V"

Allis Chalmers Mfg. Co.
General Machinery Div.
American Pulley Co.
Birdsboro Steel Foundry & Machine Co.
Boston Woven Hose & Rubber Co.
Brammer Corp.
Browning Mfg. Co.
Carlyle Rubber Co.
Chicago Pulley & Shafting Co.
Christian Engineers, J. D.
Continental Gin Co.
Industrial Div.
Dayton Rubber Co.
Dick Co., R. & J.
Dodge Mfg. Corp.
Gates Rubber Co.
Gilmer Co., L. H.
Goodall Rubber Co.
Goodrich Co., B. F.
Flat Belting
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Goodyear Tire & Rubber Co.
Industrial Products
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Iowa Mfg. Co.
Jones Foundry & Machine Co., W. A.
Link-Belt Co.
Manheim Mfg. & Belting Co.
Missouri Belting Co.
New York Belting & Packing Co.
Porter Co., H. K.
Quaker Rubber Co. Div.
Raniville Co., F.
Raybestos-Manhattan, Inc.
Manhattan Rubber Div.
Rhoads & Son, J. E.
Schieren Co., Charles A.
Sikes Co., S. R.
Thermoid Co.
Industrial Div.
Thompson-Starrett Co., Inc.
Roberts & Schaefer Co. Div.
Ton-Tex Corp.
Webb Belting & Supply Co.
Wood's Sons Co., T. B.
Worthington Corp.

BIN & CHUTE GATES and MECHANISMS

Acme Road Machinery Co.
Allen-Sherman-Hoff Co.
Blaw-Knox Co.
Bodinson Manufacturing Co., Inc.
Chain Belt Co.
Chattanooga Boiler & Tank Co.
Connellsville Mfg. & Mine Supply Co.
Conveyor Co.
Erie Strayer Co.
Fairmont Machinery Co.
Gruendler Crusher & Pulverizer Co.
Hack Engineering Co.
Helmick Foundry-Machine Co.
Hewitt-Robins, Inc.
Holmes & Bros., Inc., Robert
Iowa Mfg. Co.
Irwin Foundry & Mine Car Co.
Jeffrey Mfg. Co.
Johnson Co., C. S.
Kanawha Mfg. Co.
Koehring Co.
Link-Belt Co.
Lippmann Engineering Works
Manganese Steel Forge Co.
Marsh Engineering Co., E. F.
McNally Pittsburg Mfg. Corp.

Meckum Engineering, Inc.
Morse Bros. Machinery Co.
Ogden Iron Works
Ottumwa Box Car Loader Co.
Roners Iron Works Co.
Savage Co., W. J.
Smith Engineering Works
Stephens-Adamson Mfg. Co.
Thompson-Starrett Co., Inc.
Roberts & Schaefer Co. Div.
Transall, Inc.
Union Iron Works
Universal Dredge Mfg. Co.
Washington Machinery Co.
Williams & Green

BIN- and TANK-LEVEL INDICATORS
Bin-Dicator Co.
Convair, Inc.
Femco, Inc.
General American Transportation Corp.
Hewitt-Robins, Inc.
Jeffrey Mfg. Co.
Johnson Co. C. S.
Koehring Co.
Norton Co.
Omega Machine Co.
Richardson Scale Co.
Stephens-Adamson Mfg. Co.
Syntron Co.

BINS & CHUTES
Acme Road Machinery Co.
Allison Steel Mfg. Co.
Armco Drainage & Metal Products, Inc.
Blaw-Knox Co.
Bodinson Manufacturing Co., Inc.
Butler Bin Co.
Chattanooga Boiler & Tank Co.
Connellsville Mfg. & Mine Supply Co.
Conveyor Co.
Daniels Co. Contractors, Inc.
Denver Equipment Co.
Diamond Iron Works Div.
Goodman Mfg. Co.
Enterprise Wheel & Car Corp.
Erie Strayer Co.
Fairmont Machinery Co.
Graver Tank & Mfg. Co., Inc.
Gruendler Crusher & Pulverizer Co.
Helmick Foundry-Machine Co.
Hewitt-Robins, Inc.
Holmes & Bros., Inc., Robert
Industrial Engrg. & Construction Co.
Iowa Mfg. Co.
Irwin Foundry & Mine Car Co.
Johnson Co., C. S.
Kanawha Mfg. Co.
Kenyon Walker Machinery Co.
Kirk & Blum Mfg. Co.
Koehring Co.
Kremser & Sons, Inc., Frank A.
Lakeside Bridge & Steel Co.
Link-Belt Co.
Lippmann Engineering Works
Mahon Co., R. C.
Manganese Steel Forge Co.
Marsh Engineering Co., E. F.
Mayo Tunnel & Mine Equipment Co.
McNally Pittsburg Mfg. Corp.
Meckum Engineering, Inc.
National Iron Co.
Ogden Iron Works
Ottumwa Box Car Loader Co.
Pioneer Engineering Works, Inc.
Prins & Associates K.
Rogers Iron Works Co.
Savage Co., W. J.
Smith Engineering Works
Stephens-Adamson Mfg. Co.
Transall, Inc.
Union Iron Works
Universal Dredge Mfg. Co.
Universal Engineering Corp.
Universal Road Machinery Co.
Washington Machinery Co.
Watt Car & Wheel Co.
Williams & Green
Wisconsin Bridge & Iron Co.

BLAST CLEANING EQUIPMENT
Homestead Valve Mfg. Co.
Exolon Co.
MacLeod Co.
Pangborn Corp.
Parsons Engineering Corp.
Sly Mfg. Co., W. W.
Taylor-Wharton Co. Div.
Harsco Corp.
Wheelabrator Corp.

BLASTING BAGS, POWDER & TAMPING
American Brattice Cloth Corp.
Atlas Powder Co.
Bemis Bros. Bag Co.
Canadian Industries Ltd.
Daniels, Inc., C. R.
DuPont de Nemours & Co., Inc., E. I. Explosives Div.
DuPont de Nemours & Co., Inc., E. I. Ventube Div.
Drullard Co. Howard
Equitable Paper Bag Co., Inc.
Fulton Bag & Cotton Mills Bag Div.
Kanawha Mfg. Co.
Mine Safety Appliances Co.
Olin-Mathieson Chemical Corp. Explosives Div.
Plummer Mfg. Co., W. A.
Tamping Bag Co.
Trojan Powder Co.

BLASTING CAPS
American Cyanamid Co. Explosives Dept.
Atlas Powder Co.
Canadian Industries Ltd.
DuPont de Nemours & Co., E. I.
DuPont de Nemours & Co., Inc., E. I. Explosives Div.
Equitable Powder Mfg. Co.
Hercules Powder Co.
Illinois Powder Mfg. Co.
National Powder Co.
Trojan Powder Co.
Western Cartridge Co.

BLASTING COMPOUNDS (i.e. Explosives)
American Cyanamid Co. Explosives Dept.
Apache Powder Co.
Atlas Powder Co.
Canadian Industries Ltd.
Continental Mineral Processing Co.
DuPont de Nemours & Co., Inc., E. I. Explosives Div.
Equitable Powder Mfg. Co.
Hercules Powder Co.
Illinois Powder Mfg. Co.
Kinn Powder Co.
National Powder Co.
Olin-Mathieson Chemical Corp. Explosives Div.
Trojan Powder Co.
Vanderbilt Co., R. T.

BLASTING & DETONATING FUSES
American Cyanamid Co. Explosives Dept.
Atlas Powder Co.
Canadian Industries Ltd.
Coast Mfg. & Supply Co.
DuPont de Nemours & Co., E. I.
DuPont de Nemours & Co. Inc., E. I. Explosives Div.
Ensign-Bickford Co.
Equitable Powder Mfg. Co.
Hercules Powder Co.
Illinois Powder Mfg. Co.
National Fuse & Powder Co.
National Powder Co.
Trojan Powder Co.

BLASTING EQUIPMENT & ACCESSORIES
American Cyanamid Co. Explosives Dept.
Atlas Powder Co.
Canadian Industries Ltd
Davis Instrument Co.
Drullard Co., Howard
DuPont de Nemours & Co., E. I.
DuPont de Nemours & Co., Inc., E. I. Explosives Div.
Equitable Powder Mfg. Co.
Falcon Alarm Co., Inc.
Femco, Inc.
Gray Instrument Co.
Hammond Co., J. V.
Hercules Powder Co.
Illinois Powder Mfg. Co.
Johnson Loading Supplies, G. R.
Mahogany Importing Co.
Mine Safety Appliances Co.
National Automotive Fibres, Inc.
National Fuse & Powder Co.
National Mine Service Co.
National Powder Co.
Olin-Mathieson Chemical Corp. Explosives Div.
Quick-Seal Products, Inc.
Salem Tool Co.
Trojan Powder Co.
Victor Equipment Co.

BLASTING WIRE
Atlas Powder Co.
Canadian Industries Ltd.
Chester Cable Corp.
Colorado Fuel & Iron Co.
John A. Roebling's Sons Co. Div.
DuPont de Nemours & Co., E. I.
National Powder Co.
Rome Cable Corp.
Trojan Powder Co.

BLOCKS, PULLEYS & SHEAVES—also see Sheaves, Mine Hoist
American Hoist & Derrick Co.
Alloy Steel & Metals Co.
American Brake Shoe Co.
American Pulley Co.
Card Iron Works, C. S.
Chicago Pulley & Shafting Co.
Connellsville Mfg. & Mine Supply Co.
Continental Gin Co.
Industrial Div.
Hewitt-Robins, Inc.
Holmes & Bros., Inc. Robert
Jeffrey Mfg. Co.
Joy Mfg. Co.
Keeney Co., Paul E.
Lake Shore, Inc.
Lake Shore Engineering Div.
Le Bus Rotary Tool Works
Madesco Tackle Block Co.
Marsh Engineering Co., E. F.
McMillan's Sons, W. H.
McNally Pittsburg Mfg. Corp.
Meckum Engineering, Inc.
National Iron Co.
Ohio Hoist & Mfg. Co., Inc.
Riblet Tramway Co.
Sanford-Day Iron Works, Inc.
Sanford-Day Iron Works Brown-Fayro Div.
Sauerman Bros., Inc.
Skookum Co.
Stroh Process Steel Co.
Thompson-Starrett Co., Inc.
Roberts & Schaefer Co. Div.
Upson-Walton Co.
Washington Iron Works
Washington Machinery Co.
Western Block Co.

BLUE, PHOTO & WHITE, PRINT MACHINES
Bruning Co., Inc. Charles
Elliott Co., B. K.
General Aniline & Film Corp. Ozalid Div.
Paragon-Revolute Corp.
Pease Co., C. F.
Peck & Harvey Mfg. Corp.
Peerless Photo Products, Inc.
Silent Hoist & Crane Corp.
Remington Rand Div.
Sperry Rand Corp.

BOILERS & HEAT EXCHANGERS—also see Coolers
Alco Products, Inc.
American-Marsh Pumps, Inc.
Amex Iron Works, Inc.
Babcock & Wilcox Co.
Bigelow Co.
Binks Mfg. Co.
Blaw-Knox Co.
Braun & Co., C. F.
Carbone Corp.
Carrier Corp.
Carter Co., Ralph B.
Chattanooga Boiler & Tank Co.
Christian Engineers, J. D.
Combustion Engineering Inc.
Condenser Service & Engineering Co.
Connellsville Mfg. & Mine Supply Co.
Corning Glass Works
Duriron Co., Inc.
Erie City Iron Works
Fitzgibbons Boiler Co.
Foster Wheeler Corp.
Hapman Conveyors, Inc.
Kanawha Mfg. Co.
Keeler Co., E.
Kellogg Co., M. W.
Kennedy-Van Saun Mfg. & Eng. Corp.
Kewanee-Ross Corp.
Leffel & Co., James
Mueller Brass Co.
Murray Iron Works Co.
Ogden Iron Works
Pacific Coast Engineering Co.
Process Engineering, Inc.
Frank Prox Co., Inc.
Quick Charge, Inc.
Ross Heat Exchanger Div. American Standard
Schutte & Koerting Co.
Southwestern Engineering Co.
Springfield Boiler Co.
Union Carbide & Carbon Corp. National Carbon Co. Div.
Vogt Machine Co., Henry
Wickes Boiler Co. Div. Wickes Corp.
Willamette Iron & Steel Co.
Worthington Corp.

BOLTS—see Fasteners or Rock Bolts

BOOMS, LOADING—also see Cranes
Connellsville Mfg. & Mine Supply Co.
Continental Gin Co. Industrial Div.
Dominion Engineering Co., Ltd.
Fairmont Machinery Co.
Heyl & Patterson, Inc.
Holmes & Bros., Inc. Robert
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
McNally Pittsburgh Mfg. Corp.
Ogden Iron Works
Savage Co., W. J.
Stephens-Adamson Mfg. Co.
Thompson-Starrett Co., Inc.
Roberts & Schaefer Co. Div.
Union Iron Works
Williams & Green
Wisconsin Bridge & Iron Co.
Yuba Manufacturing Co.

BRAKES, DYNAMIC—also see Brakes, Magnetic
General Electric Co.
Ind. Haulage Div.—Loco. & Car Equip. Divs.
Westinghouse Electric Corp.

BRAKES, FRICTION & ACCESSORIES
American Chain & Cable Co., Inc. Automotive & Aircraft Div.
Gatke Corp.
Goodyear Tire & Rubber Co.
Johns-Manville
Maddox Foundry & Machine Works, Inc.
New York Air Brake Co.
Rockwell Spring & Axle Co. Timken-Detroit Axle Div.
Southern Friction Materials Co.
Wellman Co., S. E.

BRAKES, MAGNETIC
Clark Controller Co.
Cutler-Hammer, Inc.
DeWalt Inc.
Dings Magnetic Separator Co.
Dynamatic Div. Eaton Manufacturing Co.
Eaton Mfg. Co.
Electric Controller & Mfg. Co. Div. Square D. Co.
Harnischfeger Corp. P & H Diesel Div.
International General Electric Co.
Stearns Magnetic, Inc.
Trombetta Solenoid Corp.
Warner Electric Brake & Clutch Co.
Westinghouse Electric Corp.

BRATTICE CLOTH—also see Cloth & Fabric
American Brattice Cloth Corp.
Flocker & Co., John
Fulton Bag & Cotton Mills Bag Div.
Goodrich Industrial Products Co., B. F.
Johnston-Morehouse-Dickey Co.
National Mine Service Co.
Rockwell Spring & Axle Co. Timken-Detroit Axle Div.
Turner Halsey Co.
White Lamb Finaly, Inc.

BRUSHES, ELECTRICAL — see Electrical Brushes

BREAKERS, CIRCUIT—see Electrical Switchgear

BUCKET TEETH & WEAR—REPLACEMENT PARTS
American Steel Foundries
H. & L. Tooth Co.
Industrial Overlay Metals

BUCKETS, BUCKETLINE DREDGE
American Brake Shoe Co.
Blaw-Knox Co.
Connellsville Mfg. & Mine Supply Co.
Dominion Engineering Co., Ltd.
Hendrix Mfg. Co.
Heyl & Patterson, Inc.
Taylor-Wharton Co. Div. Harsco Corp.
Union Iron Works
Yaun Mfg. Co., Inc.

BUCKETS, CLAMSHELL & GRAB
American Brake Shoe Co.
Blaw-Knox Co.
Connellsville Mfg. & Mine Supply Co.
Electric Steel Foundry Co.
Erie Strayer Co.
Hales Co., W. M.
Harnischfeger Corp. P&H Diesel Div.
Hayward Co.
Heyl & Patterson, Inc.
Industrial Brownhoist Corp.
Johnson Co., C. S.
Koehring Co.
McDowell Co. Dwight-Lloyd Div.
McKiernan-Terry Corp.
Orton Crane & Shovel Co.
Owen Bucket Co.
Pettibone Mulliken Corp.
Salem-Brosius, Inc.
Schield Bantam Co.
Wellman Engineering Co. McDowell enterprise
Yaun Mfg. Co., Inc.
Yuba Manufacturing Co.

BUCKETS, CONVEYOR & ELEVATOR
Acme Road Machinery Co.
Atlas Conveyor Co.
Bartlett & Snow Co., C. O.

Beaumont Birch Co.
Bodinson Manufacturing Co., Inc.
Chain Belt Co.
Chattanooga Boiler & Tank Co.
Chicago Pulley & Shafting Co.
Connellsville Mfg. & Mine Supply Co.
Continental Gin Co.
Industrial Div.
Diamond Iron Works Div.
Goodman Mfg. Co.
Dominion Engineering Co., Ltd.
Enterprise Wheel & Car Corp.
Fairmont Machinery Co.
Farrell-Cheek Steel Co.
Gibraltar Equipment & Mfg. Co.
Gruendler Crusher & Pulverizer Co.
Hack Engineering Co.
Helmick Foundry-Machine Co.
Hewitt-Robbins, Inc.
Heyl & Patterson, Inc.
Holmes & Bros., Inc. Robert
Iowa Mfg. Co.
Irwin Foundry & Mine Car Co.
Jeffrey Mfg. Co.
Johnson Co., C. S.
Kensington Steel Co.
Kirk & Blum Mfg. Co.
Kremser & Sons, Inc., Frank A.
Link-Belt Co.
Lippmann Engineering Works
Marsh Engineering Co., E. F.
McNally Pittsburg Mfg. Corp.
Meckum Engineering, Inc.
Ogden Iron Works
Pettibone Mulliken Corp.
Prins & Associates K.
Specialty Engineering Co.
Standard Metal Mfg. Co.
Taylor-Wharton Co. Div.
Harsco Corp.
Transoil, Inc.
Union Chain & Mfg. Co.
Universal Engineering Corp.
Universal Road Machinery Co.
Washington Machinery Co.
Wilmot Engineering Co.

BUCKETS, DIPPER SHOVEL

American Brake Shoe Co.
American Brake Shoe Co.
American Steel Div.
Bay City Shovels, Inc.
Connellsville Mfg. & Mine Supply Co.
Dominion Engineering Co., Ltd.
Electric Steel Foundry Co.
Hales Co., W. M.
Harnischfeger Corp.
P&H Diesel Div.
Insley Manufacturing Corp.
Little Giant Crane & Shovel Co.
Marion Power Shovel Co.
Northwest Engineering Co.
Pettibone Mulliken Corp.
Schield Bantam Co.
Sorel Steel Foundries, Ltd.
Unit Crane & Shovel Corp.

BUCKETS, DRAGLINE

Beaumont Birch Co.
Blaw-Knox Co.
Bucyrus-Erie Co.
Connellsville Mfg. & Mine Supply Co.
Dominion Engineering Co., Ltd.
Electric Steel Foundry Co.
Hales Co., W. M.
Harnischfeger Corp.
P&H Diesel Div.
Insley Manufacturing Corp.
Page Engineering Co.
Pettibone Mulliken Corp.
Remaly Mfg. Co.
Sauerman Bros., Inc.
Schield Bantam Co.
Taylor-Wharton Co. Div.
Harsco Corp.
Union Iron Works
Wellman Engineering Co.
McDowell enterprise
Youn Mfg. Co., Inc.
Yuba Manufacturing Co.

BUCKETS, DUMPING & SINKING—also see Skips & Cages

Connellsville Mfg. & Mine Supply Co.
Easton Car & Construction Co.
Hirsch Bros. Machy. Co.
Lake Shore, Inc.
Lake Shore Engineering Div.
Salem-Brosius, Inc.
Thompson-Starrett Co., Inc.
Roberts & Schaefer Co. Div.

BUCKETS, SLUSHER-SCRAPER

Alloy Steel & Metals Co.
Connellsville Mfg. & Mine Supply Co.
Eimco Corp.
Joy Mfg. Co.
Ogden Iron Works
Rogers Iron Works Co.
Sauerman Bros., Inc.
Vulcan Iron Works Co., (Denver)
Washington Machinery Co.

BUCKETS, TRAMWAY & TROLLEY

Connellsville Mfg. & Mine Supply Co.
Riblet Tramway Co.
Union Iron Works

BUILDINGS, METAL PREFAB

Armco Drainage & Metal Products, Inc.
Arrowhead Steel Buildings, Inc.
Butler Manufacturing Co.
Dresser-Ideco Co.
Inland Steel Products Co.
Republic Steel Corp.
Truscon Steel Div.
Soule Steel Co.
Steel-Bilt Construction Co.
Steelcraft Mfg. Co.

BULLDOZER & GRADER BLADES

Allis-Chalmers Mfg. Co.
Construction Machy. Div.
Allis-Chalmers Mfg. Co.
General Machinery Div.
Allison Steel Mfg. Co.
American Brake Shoe Co.
American Steel Foundries
Arrow Mfg. Co.
Baker Mfg. Co. Div.
Allis-Chalmers Mfg. Co.
Balderson, Inc.
Caterpillar Tractor Co.
Clark Equipment Co.
Construction Machinery Div.
Colorado Fuel & Iron Corp.
Dominion Steel & Coal Corp., Ltd.
Eimco Corp.
Electric Steel Foundry Co.
Gar Wood Industries, Inc.
Hales Co., W. M.
Le Tourneau-Westinghouse Co.
Westinghouse Air Brake Co.

BULLDOZERS—also see Tractors

Arrow Mfg. Co.
Austin-Western Works
Construction Equipment Div.
Baldwin-Lima-Hamilton Corp.
Clark Equipment Co.
Construction Machinery Div.
Eimco Corp.
Euclid Div.
General Motors Corp.
Westinghouse Air Brake Co.

CABLE—see Electrical Cable or Wire Rope

CAGES, MINE HOIST—see Skips & Cages

CALCULATORS—See Drafting Instruments or Office Machines

CAP LAMPS, CARBIDE

Baldwin-Lima-Hamilton Corp.
Justrite Mfg. Co.
Penn Mfg. & Supply Co.

CAP LAMPS, ELECTRIC

Mine Safety Appliances Co.
National Mine Service Co.
Penn Mfg. & Supply Co.
Wolf Safety Lamp Co. of America, Inc.

CAP LAMP CARBIDE

Air Reduction Co., Inc.
Industrial Air Products Co.
Monsanto Chemical Co.
National Cylinder Gas Co.
Shawinigan Products Co.
Union Carbide & Carbon Co.
Linde Air Products Div.

CAR BUMPERS, RETARDERS & WHEEL CHOCKS

Aldon Co.
Card Iron Works, C. S.
Enterprise Wheel & Car Corp.
Foster Co., L. B.
Gibraltar Equipment & Mfg. Co.
Gregg Co., Ltd.
Guyan Machy. Co.
Irwin Foundry & Mine Car Co.
Kanawha Mfg. Co.
Nolan Co.
Sanford-Day Iron Works, Inc.
Watt Car & Wheel Co.

CAR CAGERS & SPOTTERS—also see Car Movers

Card Iron Works, C. S.
Connellsville Mfg. & Mine Supply Co.
Maschinenfabrik Rudolf Hausherr & Soehne, GmbH
c/o B. J. Nykerk Corp.
Nolan Co.
Stamler Corp., W. R.
Thompson-Starrett Co., Inc.
Roberts & Schaefer Co. Div.

CAR COUPLERS

Card Iron Works, C. S.
Differential Steel Car Co.
Enterprise Wheel & Car Corp.
Irwin Foundry & Mine Car Co.
Mayo Tunnel & Mine Equipment Co.
National Malleable & Steel Castings Co.
Ohio Brass Co.
Ottumwa Box Car Loader Co.
Phillips Corp.
Sanford-Day Iron Works, Inc.
Stearns Roger Mfg. Co.
Utility Mine Equipment Co.

CAR DERAILERS & RERAILERS

Aldon Co.
Foster Co., L. B.
Gibraltar Equipment & Mfg. Co.
Hales Co., W. M.
Miner's Hardware Supply Co.
Nolan Co.
Pettibone Mulliken Corp.
Sanford-Day Iron Works, Inc.
Sanford-Day Iron Works
Brown-Fayro Div.

CAR DUMPERS

Atlas Car & Mfg. Co.
Card Iron Works, C. S.
Connellsville Mfg. & Mine Supply Co.
Differential Steel Car Co.
Eastern Constructors, Inc.
Heyl & Patterson, Inc.
Holmes & Bros., Inc. Robert
Kanawha Mfg. Co.
Link-Belt Co.
McDowell Co.
Dwight-Lloyd Div.
McKiernan-Terry Corp.
McNally-Pittsburg Mfg. Corp.
Nolan Co.
Rogers Iron Works Co.
Salem-Brosius, Inc.
Thompson-Starrett Co., Inc.
Roberts & Schaefer Co. Div.
Wellman Engineering Co.
McDowell enterprise

CAR MOVERS, HAND

Advance Car Mover Co., Inc.
Aldon Co.
Atlas Car & Mfg. Co.
Broderick & Bascom Rope Co.
Christian Engineers, J. D.
Foster Co., L. B.
Gibraltar Equipment & Mfg. Co.
Holmes & Bros., Inc. Robert
Pressed Steel Car Div.
U. S. Industries, Inc.
Stimmel Winch Co., Inc.

CAR MOVERS, POWERED—see Car Cagers; or Winches

American Engineering Co.
American Hoist & Derrick Co.
Atlas Corp.
Bodinson Manufacturing Co., Inc.
Christian Engineers, J. D.
Clyde Iron Works, Inc.
Connellsville Mfg. & Mine Supply Co.
Hewitt-Robins, Inc.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Lidgerwood Industries, Inc.
Link-Belt Co.
McKiernan-Terry Corp.
O. K. Machinery Div.
John C. Motter Printing Press Co.
Sanford-Day Iron Works, Inc.
Silent Hoist & Crane Corp.
Stephens-Adamson Mfg. Co.
Stimmel Winch Co., Inc.
Superior-Lidgerwood-Mundy Corp.
Thompson-Starrett Co., Inc.
Roberts & Schaefer Co. Div.
Washington Machinery Co.
Yuba Manufacturing Co.

CAR MOVERS, SELF-PROPELLED

General Electric Co.
Ind. Haulage Div.-Loco. & Car Equip. Divs.
Hack Engineering Co.
Hough Co., Frank G.
Le Tourneau-Westinghouse Co.
Link-Belt Co.
Thompson-Starrett Co., Inc.
Roberts & Schaefer Co. Div.
Universal Dredge Mfg. Co.
Westinghouse Air Brake Co.
Whiting Corp.

CAR SHAKERS—also see Vibrators

Allis Chalmers Mfg. Co.
General Machinery Div.
Eastern Constructors, Inc.
Hewitt-Robins, Inc.
Link-Belt Co.
Simplicity Engineering Co.
Stephens-Adamson Mfg. Co.

CAR TRANSFERS

American Mine Door Co.
Atlas Car & Mfg. Co.
Card Iron Works, C. S.
Enterprise Wheel & Car Corp.
Filer & Stowell Co.

CAR WHEEL PULLERS

Armstrong-Bray & Co.
Blackhawk Mfg. Co.
Crane Puller Co.
Gibraltar Equipment & Mfg. Co.
Hewitt-Robins, Inc.
Phillips Corp.
Williams & Green

CAR (& Locomotive) WHEELS & AXLES

American Brake Shoe Co.
American Emery Wheel Works
Athey Products Corp.
Atlas Car & Mfg. Co.
Baldwin-Lima-Hamilton Corp.
Standard Steel Works Div.
Bethlehem Pacific Coast Steel Corp.
Bodinson Manufacturing Co., Inc.
Card Iron Works, C. S.
Differential Steel Car Co.
Electric Materials Co.
Enterprise Wheel & Car Corp.
Fairbanks Co.
Farrell-Cheek Steel Co.
Gibraltar Equipment & Mfg. Co.
Gregg Co., Ltd.
Hockensmith Corp.
Ironton Engine Co.
Irwin Foundry & Mine Car Co.
Sanford-Day Iron Works
Brown-Fayro Div.
Sanford-Day Iron Works, Inc.
Star Brass Works
Tool Steel Gear & Pinion Co.
U. S. Steel Corp.
Columbia-Geneva Steel Div.
Williams & Green
Wilmot Engineering Co.

CARBIDE, CALCIUM—see Cap Lamp Carbide

CARBIDE, TUNGSTEN, and other HARD METALS (Sintered, Cemented, etc.)

Adamas Carbide Corp.
Allegheny Ludlum Steel Corp.
Firth Sterling Inc.
Hoyland Steel Co.
Kennametal Inc.
Marathon Coal Bit Co.
Metal Carbides Corp.
Midwest Carbide Corp.
Union Carbide & Carbon Corp.
Haynes Stellite Div.
Vascoloy-Ramet Corp.
Willey's Carbide Tool Co.

CARS, MINE—also see specific types below

Allison Steel Mfg. Co.
American Bridge Div.
U. S. Steel Corp.
Baldwin-Lima-Hamilton Corp.
Bethlehem Steel Co., Inc.
Bethlehem Pacific Coast Steel Corp.
Card Iron Works, C. S.
Chattanooga Boiler & Tank Co.
Coeur d'Alene Hardware & Foundry Co.
Connellsville Mfg. & Mine Supply Co.
Denver Equipment Co.
Differential Steel Car Co.
Dominion Steel & Coal Corp., Ltd.
Drullard Co., Howard
Easton Car & Construction Co.
Enterprise Wheel & Car Corp.
General American Transportation Corp.
Getman Brothers
Gibraltar Equipment & Mfg. Co.
Gregg Co., Ltd.
Helmick Foundry-Machine Co.
Hirsch Bros. Machy. Co.
Hockensmith Corp.
Irwin Foundry & Mine Car Co.
Kanawha Mfg. Co.
Kersey Mfg. Co., Inc.
Lake Shore, Inc.
Lake Shore Engineering Div.
Maddox Foundry & Machine Works, Inc.
Magor Car Corp.
Mayo Tunnel & Mine Equipment Co.
Miners Foundry & Mfg. Co.
Morse Bros. Machinery Co.
Ogden Iron Works
Ottumwa Box Car Loader Co.
Phillips Corp.
Pressed Steel Car Div.
U. S. Industries, Inc.
Prime Mover Co.
Sanford-Day Iron Works, Inc.
Sanford-Day Iron Works
Brown-Fayro Div.
Schatz Mfg. Co.
Stearns Roger Mfg. Co.
Union Iron Works
Watt Car & Wheel Co.
Williams & Green

CARS, MINE, AUTOMATIC DUMP

Allison Steel Mfg. Co.
Bethlehem Steel Co., Inc.
Bethlehem Pacific Coast Steel Corp.
Card Iron Works, C. S.
Connellsville Mfg. & Mine Supply Co.
Differential Steel Car Co.
Dominion Steel & Coal Corp., Ltd.
Enterprise Wheel & Car Corp.

Getman Brothers
Gregg Co., Ltd.
Irwin Foundry & Mine Car Co.
Lake Shore, Inc.
Lake Shore Engineering Div.
Magor Car Corp.
Miners Foundry & Mfg. Co.
Ottumwa Box Car Loader Co.
Phillips Corp.
Pressed Steel Car Co. Div.
U. S. Industries, Inc.
Sanford-Day Iron Works, Inc.
Sanford-Day Iron Works
Brown-Fayro Div.
Stearns Roger Mfg. Co.
Watt Car & Wheel Co.

CARS, MINE FIRE—also see Fire Fighting Equipment

Bethlehem Pacific Coast Steel Corp.
Gregg Co., Ltd.
Irwin Foundry & Mine Car Co.
Mine Safety Appliances Co.
Ottumwa Box Car Loader Co.

CARS, MINE, HAND DUMP

Bethlehem Steel Co., Inc.
Bethlehem Pacific Coast Steel Corp.
Card Iron Works, C. S.
Connellsville Mfg. & Mine Supply Co.
Easton Car & Construction Co.
Enterprise Wheel & Car Corp.
Getman Brothers
Gregg Co., Ltd.
Irwin Foundry & Mine Car Co.
Lake Shore, Inc.
Lake Shore Engineering Div.
Magor Car Corp.
Mayo Tunnel & Mine Equipment Co.
Miner's Foundry & Mfg. Co.
Ogden Iron Works
Ottumwa Box Car Loader Co.
Sanford-Day Iron Works, Inc.
Sanford-Day Iron Works
Brown-Fayro Div.
Phillips Corp.
Union Iron Works
Williams & Green

CARS, MINE, MAN

Bethlehem Steel Co., Inc.
Bethlehem Pacific Coast Steel Corp.
Card Iron Works, C. S.
Connellsville Mfg. & Mine Supply Co.
Differential Steel Car Co.
Easton Car & Construction Co.
Enterprise Wheel & Car Corp.
Gregg Co., Ltd.
Irwin Foundry & Mine Car Co.
Miner's Foundry & Mfg. Co.
Ogden Iron Works
Ottumwa Box Car Loader Co.
Sanford-Day Iron Works, Inc.
Sanford-Day Iron Works
Brown-Fayro Div.
Union Iron Works
Watt Car & Wheel Co.

CARS, SHUTTLE—also see Trucks

Connellsville Mfg. & Mine Supply Co.
Easton Car & Construction Co.
General Electric Co.
Ind. Haulage Div.-Loco. & Car Equip. Divs.
Getman Brothers
International General Electric Co.
Irwin Foundry & Mine Car Co.
Jeffrey Mfg. Co.
Miner's Foundry & Mfg. Co.
Myers-Whaley Co. Inc.
Ottumwa Box Car Loader Co.

CASTINGS, ALUMINUM, BRASS & OTHER NONFERROUS

Aluminum Co. of America
American Brake Shoe Co.
American Crucible Products Co.
American Hoist & Derrick Co.
American-Marsh Pumps, Inc.
American Smelting & Refining Co.
Ampco Metal, Inc.
Belmont Smelting & Refining Works, Inc.
Beryllium Corp.
Bethlehem Steel Co., Inc.
Bethlehem Pacific Coast Steel Corp.
Bohn Aluminum & Brass Corp.
Brass Foundry Co.
Bridgeport Brass Co.
Cadman Mfg. Co., A. W.
Chase Brass & Copper Co.
Construction Machy. Co.
Dominion Engineering Co., Ltd.
Electric Materials Co.
Enterprise Wheel & Car Corp.
Flood City Brass & Elec. Co.
Franklin Brass Foundry Co.
Frontier Bronze Co.
Gabraltar Equipment & Mfg. Co.
Goyne Steam Pump Co.
Helmick Foundry-Machine Co.
Illinois Iron & Bolt Co.
Imperial-Cantrell Mfg. Co.
International Nickel Co.
Johnson Bronze Co.
Lattimer Foundry & Machine Co.
Leavitt Machine Co.
Lumen Bearing Co.
Maddox Foundry & Machine Works, Inc.
Mueller Brass Co.
National Lead Co.
New York Air Brake Co.
Nordberg Mfg. Co.
Ogden Iron Works
Olds Alloy Co.
Penn Machine Co.
Permold Co.
Saginaw Bearing Co.
Savage Co., W. J.
Seymour Mfg. Co.
Ster Brass Works
Stewart-Warner Corp.
Alemite Div.
Stoody Co.
Troy Engine & Machine Co.
Union Iron Works
United American Metals Corp.
Weatherly Foundry & Mfg. Co.
West Virginia Armature Co.
Westinghouse Air Brake Co.
Ind. Products Div.
Williams & Son, E. A.
Wright Engineering & Supply Co.
New Products Development

CASTINGS, GRAY IRON

American Brake Shoe Co.
American Cast Iron Pipe Co.
American Chain & Cable Co., Inc.
ACCO Casting Div.
American Hoist & Derrick Co.
American-Marsh Pumps, Inc.
Bethlehem Foundry & Machine Co.
Bethlehem Steel Co., Inc.
Bethlehem Pacific Coast Steel Corp.
Bigelow-Liptak Corp.
Blaw-Knox Co.
Card Iron Works, C. S.
Calumet Div.
Calumet & Hecla, Inc.
Carver Pump Co.
Chain Belt Co.
Consolidated Iron-Steel Mfg. Co.
Construction Machy. Co.
Continental Gin Co.
Industrial Div.
Cooper-Bessemer Corp.
Eagle Iron Works
Enterprise Wheel & Car Corp.
Erie City Iron Works
Farrel-Birmingham Co., Inc.
Filer & Stowell Co.
Frank Prox Co., Inc.
Gibraltar Equipment & Mfg. Co.
Goyne Steam Pump Co.
Helmick Foundry-Machine Co.
Hewitt-Robins, Inc.
Iowa Mfg. Co.
Irwin Foundry & Mine Car Co.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Lake Shore, Inc.
Lake Shore Engineering Div.
Link-Belt Co.
Maddox Foundry & Machine Works, Inc.
McLanahan & Stone Corp.
McNally Pittsburg Mfg. Corp.
Murray Iron Works Co.
National Iron Co.
New York Air Brake Co.
Nordberg Mfg. Co.
Novo Pump & Engine Co.
Ogden Iron Works
Racine Steel Castings Co.
Rogers Iron Works Co.
Sanford-Day Iron Works, Inc.
Sanford-Day Iron Works
Brown-Fayro Div.
Savage Co., W. J.
Sheppard Co., Inc., R. H.
Swett Iron Works, A. L.
Thomas Foundries, Inc.
Troy Engine & Machine Co.
Union Chain & Mfg. Co.
Union Iron Works
Warren Foundry & Pipe Corp.
Washington Iron Works
Webster Mfg., Inc.
Westinghouse Air Brake Co.
Ind. Products Div.
Wilmot Engineering Co.
Wood's Sons Co., T. B.

CASTINGS, MALLEABLE IRON

American Chain & Cable Co., Inc.
ACCO Casting Div.
American-Marsh Pumps, Inc.
Badger Malleable & Mfg. Co.
Bethlehem Pacific Coast Steel Corp.
Cadillac Malleable Iron Co.
Chain Belt Co.
Link-Belt Co.
Malleable Iron Fittings Co.
Meeker Foundry Co.
National Malleable & Steel Castings Co.
Novo Pump & Engine Co.
Racine Steel Castings Co.
St. Louis Malleable Casting Co.
Sanford-Day Iron Works
Brown-Fayro Div.
Webster Mfg., Inc.

CASTINGS, MANGANESE, MEEHANITE & OTHER FERROUS ALLOYS

American Brake Shoe Co.
American Brake Shoe Co.
American Steel Div.
American-Marsh Pumps, Inc.
Babcock & Wilcox Co.
Bethlehem Foundry & Machine Co.
Bethlehem Steel Co., Inc.
Bethlehem Pacific Coast Steel Corp.
Bigelow-Liptak Corp.
Calumet Div.
Calumet & Hecla, Inc.
Coast Metals, Inc.
Continental Gin Co.
Industrial Div.
Continental Ore Corp.
Cooper-Bessemer Corp.
Dart Truck Co.
Eagle Iron Works
Electric Steel Foundry Co.
Farrel-Birmingham Co., Inc.
Gibraltar Equipment & Mfg. Co.
Goyne Steam Pump Co.
Hardinge Co., Inc.
Helmick Foundry-Machine Co.
Kanawha Mfg. Co.
Kensington Steel Co.
Lebanon Steel Foundry
Los Angeles Steel Casting Co.
Magnolia Metal Co.
McCulloch Motors Corp.
Meckum Engineering, Inc.
Meehanite Metal Corp.
Michigan-Standard Alloy Casting Co.
Murray Iron Works Co.
National Iron Co.
National Malleable & Steel Castings Co.
Nordberg Mfg. Co.
Patten Engineering Co.
Sheppard Co., Inc., R. H.
Sorel Steel Foundries Ltd.
Stearns Roger Mfg. Co.
Taylor-Wharton Co. Div.
Harsco Corp.
Thomas Foundries, Inc.
Union Spring & Mfg. Co.
Washington Iron Works

CASTINGS, STEEL

Allegheny Ludlum Steel Corp.
Alloy Steel & Metals Co.
American Chain & Cable Co., Inc.
ACCO Casting Div.
American Hoist & Derrick Co.
Atlas Steel Casting Co.
Babcock & Wilcox Co.
Baldwin-Lima-Hamilton Corp.
Standard Steel Works Div.
Birdsboro Steel Foundry & Machine Co.
Bethlehem Steel Co., Inc.
Bethlehem Pacific Coast Steel Corp.
Blaw-Knox Co.
Card Iron Works, C. S.
Cincinnati Steel Castings Co.
Crucible Steel Co. of America
Dominion Engineering Co., Ltd.
Duriron Co., Inc.
Elmco Corp.
Electric Steel Foundry Co.
Empire Steel Castings, Inc.
Falk Corp.
Farrel-Birmingham Co., Inc.
Farrell-Cheek Steel Co.
Gibraltar Equipment & Mfg. Co.
Jessop Steel Co.
Lebanon Steel Foundry
Link-Belt Co.
Los Angeles Steel Casting Co.
Malleable Iron Fittings Co.
Meckum Engineering, Inc.
Midvale—Heppenstall
National Iron Co.
National Malleable & Steel Castings Co.
Racine Steel Castings Co.
Reliance Steel Casting Co.
Ryerson & Son, Inc., Joseph T.
Sorel Steel Foundries, Ltd.
Sterling Steel Casting Co.
Stroh Process Steel Co.
Strong Steel Foundry Co.
Union Iron Works
Union Spring & Mfg. Co.
Washington Iron Works
Washington Machinery Co.

CHAIN, CAST & WELDED

American Chain & Cable Co., Inc.
American Brake Shoe Co.
Boston Metals Co.
Bridgeport Chain & Mfg. Co.
Carroll Chain Co.
Chain Belt Co.
Cleveland Chain & Mfg. Co.
Electric Steel Foundry Co.
Farrell-Cheek Steel Co.
Flocker & Co., John
Jeffrey Mfg. Co.
Kensington Steel Co.
Link-Belt Co.
McMillan's Sons, W. H.
McNally Pittsburg Mfg. Corp.
National Malleable & Steel Castings Co.
Newhall Chain Forge & Iron Co.
Ohio Hoist & Mfg. Co., Inc.
Olds Alloy Co.
Page Engineering Co.
Ryerson & Son, Inc., Joseph T.
Taylor Chain Co., S. G.
Taylor-Wharton Co. Div.
Harsco Corp.
Union Chain & Mfg. Co.
Webster Mfg., Inc.
Wilmot Engineering Co.
Woodhouse Chain Works

CHAIN, POWER TRANSMISSION

Atlas Chain & Mfg. Co.
Bartlett & Snow Co., C. O.
Borg-Warner Corp.
Morse Chain Co. Div.
Browning Mfg. Co.
Chain Belt Co.
Chicago Pulley & Shafting Co.
Christian Engineers, J. D.
Cullman Wheel Co.
Diamond Chain Co., Inc.
Dodge Mfg. Corp.
Jeffrey Mfg. Co.
Link-Belt Co.
Morse Chain Co.
Transall, Inc.
Union Chain & Mfg. Co.
Whitney Chain Co.

CHAIN SLINGS

American Chain & Cable Co., Inc.
Flocker & Co., John
Manning, Maxwell & Moore Inc.
Shaw Box Crane & Hoist Div.
Newhall Chain Forge & Iron Co.
Paulsen-Webber Cordage Corp.
Ryerson & Son, Inc., Joseph T.
Taylor Chain Co., S. G.
United States Steel Supply Co.

CHAIN SPROCKETS

American Brake Shoe Co.
American Brake Shoe Co.
American Steel Div.
Atlas Chain & Mfg. Co.
Bartlett & Snow Co., C. O.
Bodinson Manufacturing Co., Inc.
Borg-Warner Corp.
Morse Chain Co. Div.
Bowdil Co.
Brad Foote Gear Works
Pittsburgh Gear Co. Div.
Browning Mfg. Co.
Chain Belt Co.
Chicago Gear Mfg. Co.
Chicago Pulley & Shafting Co.
Christian Engineers, J. D.
Cincinnati Mine Machinery Co.
Mining Div.
Clarkson Manufacturing Co.
Continental Gin Co.
Industrial Div.
Conveyor Co.
Cullman Wheel Co.
Diamond Chain Co., Inc.
Dodge Mfg. Corp.
Fairmont Machinery Co.
Farrell-Cheek Steel Co.
Hirsch Bros. Machy. Co.
Irwin Foundry & Mine Car Co.
Jeffrey Mfg. Co.
Johnson Co., C. S.
Kanawha Mfg. Co.
Kensington Steel Co.
Link-Belt Co.
Maddox Foundry & Machine Works, Inc.
Massachusetts Gear & Tool Co.
McNally Pittsburg Mfg. Corp.
Morse Chain Co.
National Iron Co.
Northern Conveyor Co.
Olds Alloy Co.
Prins & Associates K.
Savage Co., W. J.
Stroh Process Steel Co.
Taylor-Wharton Co. Div.
Harsco Corp.
Tool Steel Gear & Pinion Co.
Transall, Inc.
Union Chain & Mfg. Co.
Universal Vibrating Screen Co.
Voland & Sons, Inc.
Washington Machinery Co.
Webster Mfg., Inc.
Whitney Chain Co.
Wilmot Engineering Co.
Yuba Manufacturing Co.

CHANGE ROOM EQUIPMENT

Channon Corp., J. H.
Moore Co. (W. Va.)

CHEMICALS—also see Flotation Re-

agents or Water Treatment Chemicals
Aluminum Co. of America
American Cyanamid Co. Mineral Dressing Dept.
American Potash & Chemical Corp.
Apache Powder Co.
Armour & Co.
Atlas Powder Co.
Baker Chemical Co., J. T.
Barrett Div.
Allied Chemical & Dye Corp.
Belmont Smelting & Refining Works, Inc.
Canadian Industries Ltd.
Calcium Chloride Institute
DuPont de Nemours & Co., E. I.
Emery Industries, Inc.
Food Machinery & Chemical Corp.
Westvaco Mineral Products Div.
Westvaco Chlor-Alkali Div.
Foote Mineral Co.
General Chemical Div.
Allied Chemical & Dye Corp.
General Chemical Div.
Allied Chemical & Dye Corp.
Baker & Adamson Products
General Mills, Inc.
Hercules Powder Co.
International General Electric Co.
Jarrell-Ash Co.
Koppers Co., Inc.
Mallinckrodt Chemical Works
Matheson Co., Inc.
Merck & Co.
Monsanto Chemical Co.
New Jersey Zinc Co.
Philadelphia Quartz Co.
Phillips Petroleum Co.
Pittsburgh Plate Glass Co.
Columbia-Southern Div.
Quick Charge, Inc.
Osmose Wood Preserving Co.
Sharples Chemicals Div.
Pennsylvania Salt Mfg. Co.
Shell Oil Co.
Snell, Inc., Foster D.
Solvay Process Div.
Allied Chemical & D e Corp.
Stein, Hall & Co., Inc.
Snyder Mine & Chemical Lab.
Trojan Powder Co.
U. S. Rubber Co.
Naugatuck Chemical Div.
Van Waters & Rogers, Inc.
Wyandotte Chemicals Corp.
Michigan Alkali Div.

CLASSIFIERS—see specific type below; also see Separators or Thickeners
Acme Road Machinery Co.
Eagle Iron Works
Hirsch Bros. Machy. Co.
Majac Inc.
McLanahan & Stone Corp.
Simplicity Engineering Co.
Smith Engineering Works
Western Machinery Co.

CLASSIFIERS, AIR
Aerofall Mills, Inc.
Arrow Hart & Hegeman Electric Co.
Combustion Engineering, Inc.
Raymond Div.
Dynamatic Div.
Eaton Manufacturing Co.
Hardinge Co., Inc.
Majac Inc.
Patterson Foundry & Machine Co.
Sturtevant Mill Co.
Thompson-Starrett Co., Inc.
Roberts & Schaefer Co. Div.
Universal Road Machinery Co.

CLASSIFIERS, BELT
Atlas Copco Eastern, Inc.
Denver Equipment Co.
Thompson-Starrett Co., Inc.
Roberts & Schaefer Co. Div.

CLASSIFIERS, BOWL-RAKE
Georgia Iron Works Co.
Kennedy-Van Saun Mfg. & Eng. Corp.
Simplicity System Co.
Thompson-Starrett Co., Inc.
Roberts & Schaefer Co. Div.

CLASSIFIERS, CYCLONE
Bartlett & Snow Co., C. O.
Bodinson Manufacturing Co., Inc.
Chattanooga Boiler & Tank Co.
Canvair, Inc.
Daniels Co. Contractors, Inc.
Denver Equipment Co.
Dorr-Oliver, Inc.
Ducon, Inc.
Equipment Engineers
Fairmont Machinery Co.
Georgia Iron Works Co.
Hardinge Co., Inc.
Heyl & Patterson, Inc.
Houston Tool Co., Inc.
Kennedy-Van Saun Mfg. & Eng. Corp.
Kirk & Blum Mfg. Co.
McNally Pittsburg Mfg. Corp.
Meckum Engineering, Inc.
Morse Brothers Machinery Co.
Peterson Filters & Engr. Co.
Simplicity System Co.
Smith Engineering Works
Standard Steel Corp.
Sturtevant Mill Co.
Western Machinery Co.

CLASSIFIERS, HYDRAULIC
Bird Machine Co.
Deister Machine Co.
Denver Equipment Co.
Dorr-Oliver, Inc.
Eagle Iron Works
Fahrenwald Co., A. W.
Hardinge Co., Inc.
Kennedy-Van Saun Mfg. & Eng. Corp.
Meckum Engineering, Inc.
Mine & Smelter Supply Co.
Marcy Mill Div.
Thompson-Starrett Co., Inc.
Roberts & Schaefer Co. Div.
Smith Engineering Works
Wilmot Engineering Co.

CLASSIFIERS, RAKE
Dorr-Oliver, Inc.
Kenyon Walker Machinery Co.
Link-Belt Co.
Morse Bros. Machinery Co.

CLASSIFIERS, SPIRAL (Screw)
Christian Engineers, J. D.
Colorado Iron Works
Denver Equipment Co.
Eagle Iron Works
Humphreys Investment Co. Engineering Div.
Jeffrey Mfg. Co.
Link-Belt Co.
Lippmann Engineering Works
Mine & Smelter Supply Co.
Marcy Mill Div.
Smith Engineering Works
Southwestern Engineering Co.
Straub Mfg. Co.

CLOTH & FABRIC—also see Bags; Brattice; Filter; Insulation; or Wire
Gering Products, Inc.

CLUTCHES, FLUID—see Drives, Fluid

CLUTCHES, FRICTION
Centric Clutch Co.
Conway Clutch Co.
Fawick Airflex Co., Inc.
Hayes Steel Products, Ltd.
Jeffrey Mfg. Co.
Johnson Machine Co., Carlyle
Link-Belt Co.
Marland One-Way Clutch Co.
Morse Chain Co.
Straub Mfg. Co.
Twin Disc Clutch Co.
Wonway Clutch Co.

CLUTCHES, MAGNETIC—also see Brakes, Magnetic
Dings Magnetic Separator Co.
Dynamatic Div.
Eaton Manufacturing Co.

COATINGS, ABRASION RESISTANT, METALLIC—see Hardfacing

COATINGS, ABRASION RESISTANT, NON-METALLIC—also see Linings
American-Marsh Pumps, Inc.
Carboline Co.
DuPont de Nemours & Co., E. I.
Royston Laboratories
Zophar Mills

COATINGS, CHEMICAL & CORROSION RESISTANT, METALLIC —see Metallizing

COATINGS, CHEMICAL & CORROSION RESISTANT, NON-METALLIC—also see Linings
American-Marsh Pumps, Inc.
Carboline Co.
DuPont de Nemours & Co., E. I.
Esso Standard Oil Co.
Gates Engrg. Co.
Royston Laboratories
Slip-On, Inc.
Sonneborn Sons, Inc., L.
Southwestern Petroleum Co.
Zophar Mills

COMMUNICATIONS, RADIO—also see Television
Federal Telephone & Radio Div.
International Telephone and Telegraph Corp.
Femco, Inc.
Graybar Elec. Co., Inc.
International General Electric Co.
Mine Safety Appliances Co.
Motorola Communications & Electronics, Inc.
Radio Corp. of America Communications Products Dept.
Westinghouse Air Brake Co.

COMMUNICATIONS, BELL, BUZZER & HORN
Auth Electric Co.
Davis Instrument Co.
Falcon Alarm Co., Inc.
Femco, Inc.
Graybar Elec. Co., Inc.
International Business Machine Corp.
Partrick & Wilkins Co.

COMMUNICATIONS, TELEPHONE
Automatic Electric Co.
Federal Telephone & Radio Div.
International Telephone and Telegraph Corp.
Femco, Inc.
Graybar Elec. Co., Inc.
Hose-McCann Telephone Co.
Mine Safety Appliances Co.
Sperry Corp., Wheeler Insulated Wire Co.
Talk-A-Phone Co.
Wheeler Insulated Wire Co., Div.
Sperry Rand Corp.

COMMUNICATIONS, TELEVISION
Curtiss-Wright Corp.
Diamond Power Specialty Corp.
General Electric Co.
Ind. Haulage Div.—Loco. & Car Equip. Divs.
Graybar Elec. Co., Inc.
International General Electric Co.

COMMUNICATIONS, VISUAL—see Rail Signals; or Signs; Posters

COMPRESSORS, AIR, MOVABLE & PORTABLE
Acme Machinery Co.
American Brake Shoe Co.
American-Marsh Pumps, Inc.
Atlas Copco Pacific, Inc.
Binks Mfg. Co.
Black Mfg. Co.
Cardox Corp.
Chicago Pneumatic Tool Co.
Curtis Manufacturing Co.
Davey Compressor Co.
Equitable Powder Mfg. Co.
Essick Manufacturing Co.
Gardner Denver Co.
Holman Bros. (Canada) Ltd.
Imperial-Cantrell Mfg. Co.
Ingersoll-Rand Co.
Jaeger Machine Co.
Joy Mfg. Co.
Le Roi Div.
Westinghouse Air Brake Co.
O. K. Machinery Div.
John C. Motter Printing Press Co.
Schramm, Inc.
Smith & Co., Gordon
Westinghouse Air Brake Co.
Worthington Corp.

COMPRESSORS, AIR, STATIONARY
Allis Chalmers Mfg. Co.
General Machinery Div.
American Brake Shoe Co.
American-Marsh Pumps, Inc.
Atlas Copco Eastern, Inc.
Atlas Copco Pacific, Inc.
Binks Mfg. Co.
Black Mfg. Co.
Cardox Corp.
Chicago Pneumatic Tool Co.
Clark Brothers Co., Div.
Dresser Operations, Inc.
Cooper-Bessemer Corp.
Curtis Manufacturing Co.
Davey Compressor Co.
Dominion Engineering Co., Ltd.
Equitable Powder Mfg. Co.
Essick Manufacturing Co.
Fuller Co.
Gardner Denver Co.
Holman Bros. (Canada), Ltd.
Imperial-Cantrell Mfg. Co.
Ingersoll-Rand Co.
Jaeger Machine Co.
Joy Mfg. Co.
Le Roi Div.
Westinghouse Air Brake Co.
Nash Engineering Co.
Pennsylvania Pump & Compressor Co.
Schramm, Inc.
Smith & Co., Gordon
Spencer Turbine Co.
Westinghouse Air Brake Co.
Worthington Corp.

CONCENTRATORS—see Classifiers or Separators

CONCRETE PLACERS—see Pumps (& Blowers) Concrete

CONCRETE ADDITIVES—also see Freezeproofing Materials
Calcium Chloride Institute
Master Builders Co.
Sonneborn Sons, Inc., L.
Southwestern Petroleum Co.

CONSULTANTS—see Searchlight Section

CONTINUOUS MINERS & PLANERS —also see Cutting Machines
Clarkson Manufacturing Co.
Eagle Iron Works
Jeffrey Mfg. Co.
Joy Mfg. Co.
Lee-Norse Co.
Westfalia Lunen
Westinghouse Air Brake Co.

CONTROLS: ELECTRICAL & ELECTRONIC (Automatic, Remote, Indicating, Recording, etc.)—also see Meters
Allis Chalmers Mfg. Co.
General Machinery Div.
Automatic Switch Co.
Conveyor Co.
Euclid Electric & Mfg. Co.
Federal Pacific Electric Co.
Femco, Inc.
Graybar Elec. Co., Inc.
Hardinge Co., Inc.
International General Electric Co.
La Roe Instruments, Inc.
Ledeen Mfg. Co.
Logan Engineering Co.
Paragon Electric Co.
Sangamo Electric Co.
Special Instruments Laboratory, Inc.
Westinghouse Air Brake Co.

CONTROLS, HYDRAULIC & PNEUMATIC (Auto., Remote, etc.)—also see Meters
American Chain & Cable Co., Inc.
Automotive & Aircraft Div.
Cash Co., A. W.
Conveyor Co.
Industrial Physics & Electronics Co.
Ledeen Mfg. Co.
Vickers, Inc.

CONVEYOR BELTING
American Rubber Mfg. Co.
Baldwin-Lima-Hamilton Corp.
Boston Woven Hose & Rubber Co.
Carlyle Rubber Co.
Chicago Pulley & Shafting Co.
Cincinnati Rubber Mfg. Co.
Colorado Fuel & Iron Corp.
Colorado Fuel & Iron Corp.
Wickwire Spencer Steel Div.
Conveyor Co.
Dick Co., R. & J.
Gilmer Co., L. H.
Goodall Rubber Co.
Goodrich Co., B. F.
Truck & Bus Tire Dept.
Goodrich Industrial Products Co., B. F.
Goodyear Tire & Rubber Co.
Industrial Products
Hales Co., W. M.
Hamilton Rubber Mfg. Corp.
Hewitt-Robins, Inc.
Holmes & Bros., Inc., Robert
Iowa Mfg. Co.
Link-Belt Co.
Missouri Belting Co.
National Mine Service Co.
New York Belting & Packing Co.
New York Rubber Corp.
Northern Conveyor Co.
Oliver Corp.
A. B. Farquhar Div.
Philadelphia Belting Co.
Porter Co., Inc., H. K.
Quaker Pioneer Rubber Div.
Raybestos-Manhattan, Inc.
Manhattan Rubber Div.
Republic Rubber Div.
Lee Rubber & Tire Corp.
Rhoads & Son, J. E.
Scandinavia Belting Co.
Schieren Co., Charles A.
Thermoid Co.
Industrial Div.
Thor Power Tool Co.
Ton-Tex Corp.
Transall, Inc.
U. S. Rubber Co.
Mechanical Goods Div.
United States Steel Supply Co.
Webb Belting & Supply Co.

CONVEYOR BELTING FASTENERS
Armstrong-Bray & Co.

CONVEYOR BELTING VULCANIZERS
Goodrich Industrial Products Co., B. F.
Heintz Mfg. Co.
Ton-Tex Corp.
West Virginia Belt & Cable Repairs, Inc.

CONVEYOR IDLERS & PULLEYS
Acme Road Machinery Co.

Atlas Conveyor Co.
Barber-Greene Co.
Bartlett & Snow Co., C. O.
Bodinson Manufacturing Co., Inc.
Bonded Scale & Machine Co.
Chain Belt Co.
Chicago Pulley & Shafting Co.
Christian Engineers, J. D.
Continental Gin Co.
  Industrial Div.
Conveyor Co.
Davis Foundry & Machine Works
Farrell-Cheek Steel Co.
Food Machinery & Chemical Corp.
  Packing Equipment Div.
Gallagher Co.
Goodyear Tire & Rubber Co.
Hewitt-Robins, Inc.
Holmes & Bros., Inc., Robert
Iowa Mfg. Co.
Irwin Foundry & Mine Car Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Kennedy-Van Saun Mfg. & Eng. Corp.
Kremser & Sons, Inc., Frank A.
Lamson Corp.
Link-Belt Co.
Lippmann Engineering Works
Marsh Engineering Co., E. F.
Mathews Conveyor Co.
Mavor & Coulson, Ltd.
McNally Pittsburg Mfg. Corp.
Northern Conveyor Co.
Ogden Iron Works
Oliver Corp.
  A. B. Farquhar Div.
Ottumwa Box Car Loader Co.
Pettibone Mulliken Corp.
Pioneer Engineering Works, Inc.
Smith Engineering Works
Stephens-Adamson Mfg. Co.
Transall, Inc.
Webster Mfg., Inc.
Yuba Manufacturing Co.

CONVEYORS—see specific type below; also see Feeders

CONVEYORS, APRON—see Conveyors, Pan

CONVEYORS, BELT

Acme Road Machinery Co.
American Conveyor Co.
Atlas Conveyor Co.
Baldwin-Lima-Hamilton Corp.
Baldwin-Lima-Hamilton Corp. Construction Equipment Div.
Barber-Greene Co.
Bartlett & Snow Co., C. O.
Baughman Manufacturing Co., Inc.
Beaumont Birch Co.
Bonded Scale & Machine Co.
Carpco Manufacturing, Inc.
Chain Belt Co.
Chicago Pulley & Shafting Co.
Christian Engineers, J. D.
Colorado Fuel & Iron Corp. Wickwire Spencer Steel Div.
Continental Gin Co.
  Industrial Div.
Conveyor Co.
Conveyor Systems, Inc.
Davis Foundry & Machine Works
Denver Equipment Co.
Diamond Iron Works Div.
  Goodman Mfg. Co.
Dominion Engineering Co., Ltd.
Fairmont Machinery Co.
Filer & Stowell Co.
Food Machinery & Chemical Corp.
  Packing Equipment Div.
Gallagher Co.
Goodrich Co., B. F.
  Flat Belting
Goodrich Industrial Products Co., B. F.
Goodyear Tire & Rubber Co.
  Industrial Products
Gruendler Crusher & Pulverizer Co.
Hamilton Rubber Mfg. Corp.
Hewitt-Robins, Inc.
Hirsch Bros. Machy. Co.
Holmes & Bros., Inc., Robert
Iowa Mfg. Co.
Industrial Engrg. & Construction Co.
Irwin Foundry & Mine Car Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Kanawha Mfg. Co.
Kennedy-Van Saun Mfg. & Eng. Corp.
Lake Shore, Inc.
  Lake Shore Engineering Div.
Lamson Corp.
Link-Belt Co.
Lippmann Engineering Works
Marsh Engineering Co., E. F.
Mavor & Coulson, Ltd.
Mayo Tunnel & Mine Equipment Co.
McNally Pittsburg Mfg. Corp.
Meckum Engineering, Inc.
New York Belting & Packing Co.
Northern Conveyor Co.
Ogden Iron Works
Oliver Corp.
  A. B. Farquhar Div.
Ottumwa Box Car Loader Co.
Pacific Coast Engineering Co.
Pioneer Engineering Works, Inc.
Porter Co., Inc., H. K.
  Quaker Pioneer Rubber Div.
Prins & Associates K.
Ridge Equipment Co.
Savage Co., W. J.
Smith Engineering Works
Specialty Engineering Co.
Stephens-Adamson Mfg. Co.
Sturtevant Mill Co.
Thompson-Starrett Co., Inc.
  Roberts & Schaefer Co. Div.
Thor Power Tool Co.
Transall, Inc.
U. S. Rubber Co.
  Mechanical Goods Div.
Universal Engineering Corp.
Universal Road Machinery Co.
Washington Machinery Co.
Webb Belting & Supply Co.
Webb Co., Jervis B.
Webster Mfg., Inc.

CONVEYORS, BELT, TAKE-UPS

Atlas Conveyor Co.
Baldwin-Lima-Hamilton Corp.
Barber-Greene Co.
Bartlett & Snow Co., C. O.
Bonded Scale & Machine Co.
Chain Belt Co.
Chicago Pulley & Shafting Co.
Continental Gin Co.
  Industrial Div.
Conveyor Co.
Conveyor Systems, Inc.
Fairmont Machinery Co.
Hewitt-Robins, Inc.
Iowa Mfg. Co.
Joy Mfg. Co.
Kremser & Sons, Inc., Frank A.
Lamson Corp.
Link-Belt Co.
Marsh Engineering Co., E. F.
McNally Pittsburg Mfg. Corp.
Northern Conveyor Co.
Ogden Iron Works
Pioneer Engineering Works, Inc.
Stephens-Adamson Mfg. Co.
Transall, Inc.
Webb Belting & Supply Co.

CONVEYORS, BELT FASTENERS

Baldwin-Lima-Hamilton Corp.
Chicago Pulley & Shafting Co.
Clipper Belt Lacer Co.
Conveyor Co.
Crescent Belt Fastener Co.
Flexible Steel Lacing Co.
General Splice Corp.
Iowa Mfg. Co.
Missouri Belting Co.
National Mine Service Co.
Northern Conveyor Co.
Raniville Co., F.
Raybestos-Manhattan, Inc. Manhattan Rubber Div.
Sawyer Belt Hook & Wedge Co., Inc.
Talcott, Inc., W. O. & M. W.
Ton-Tex Corp.
Transall, Inc.
U. S. Rubber Co.
  Mechanical Goods Div.
Webb Belting & Supply Co.

CONVEYORS, BELT, TRIPPERS

Bartlett & Snow Co., C. O.
Bodinson Manufacturing Co., Inc.
Chain Belt Co.
Christian Engineers, J. D.
Continental Gin Co.
  Industrial Div.
Conveyor Co.
Hack Engineering Co.
Hewitt-Robins, Inc.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Link-Belt Co.
Marsh Engineering Co., E. F.
McNally Pittsburg Mfg. Corp.
Ogden Iron Works
Stephens-Adamson Mfg. Co.
Transall, Inc.
Universal Dredge Mfg. Co.
Washington Machinery Co.
Webster Mfg., Inc.

CONVEYORS (& ELEVATORS), BUCKET

Acme Road Machinery Co.
American Conveyor Co.
Atlas Conveyor Co.
Baldwin-Lima-Hamilton Corp. Construction Equipment Div.
Bartlett & Snow Co., C. O.
Baughman Manufacturing Co., Inc.
Beaumont Birch Co.
Bodinson Manufacturing Co., Inc.
Bonded Scale & Machine Co.
Carpco Manufacturing, Inc.
Chain Belt Co.
Chicago Pulley & Shafting Co.
Christian Engineers, J. D.
Columbus Conveyor Co.
Connellsville Mfg. & Mine Supply Co.
Continental Gin Co.
  Industrial Div.
Conveyor Co.
Conveyor Systems, Inc.
Denver Equipment Co.
Diamond Iron Works Div.
  Goodman Mfg. Co.
Erie Strayer Co.
Gallagher Co.
Gibraltar Equipment & Mfg. Co.
Goodrich Industrial Products Co., B. F.
Goodyear Tire & Rubber Co.
  Industrial Products
Gruendler Crusher & Pulverizer Co.
Hack Engineering Co.
Hapman Conveyors, Inc.
Hewitt-Robins, Inc.
Heyl & Patterson, Inc.
Hirsch Bros. Machy. Co.
Holmes & Bros., Inc., Robert
Iowa Mfg. Co.
Jeffrey Mfg. Co.
Johnson Co., C. S.
Kanawha Mfg. Co.
Koehring Co.
Kremser & Sons, Inc., Frank A.
Link-Belt Co.
Lippmann Engineering Works
Marsh Engineering Co., E. F.
Meckum Engineering, Inc.
Northern Conveyor Co.
Ogden Iron Works
Omega Machine Co.
Pioneer Engineering Works, Inc.
Prins & Associates K.
Rogers Iron Works Co.
Savage Co., W. J.
Smith Engineering Works
Specialty Engineering Co.
Stephens-Adamson Mfg. Co.
Sturtevant Mill Co.
Thompson-Starrett Co., Inc.
  Roberts & Schaefer Co. Div.
Transall, Inc.
Union Chain & Mfg. Co.
Universal Dredge Mfg. Co.
Universal Road Machinery Co.
Washington Machinery Co.
Webb Belting & Supply Co.
Webster Mfg., Inc.
Williams & Green
Yuba Manufacturing Co.

CONVEYORS, CHAIN

American Conveyor Co.
Atlas Conveyor Co.
Bartlett & Snow Co., C. O.
Beaumont Birch Co.
Bodinson Manufacturing Co., Inc.
Bonded Scale & Machine Co.
Chain Belt Co.
Chicago Pulley & Shafting Co.
Christian Engineers, J. D.
Clarkson Manufacturing Co.
Connellsville Mfg. & Mine Supply Co.
Continental Gin Co.
  Industrial Div.
Conveyor Co.
Conveyor Systems, Inc.
Diamond Chain Co., Inc.
Fairmont Machinery Co.
Filer & Stowell Co.
Food Machinery & Chemical Corp.
  Packing Equipment Div.
Gibraltar Equipment & Mfg. Co.
Hapman Conveyors, Inc.
Hirsch Bros. Machy. Co.
Holmes & Bros., Inc., Robert
Indiana Commercial Filters Corp.
Industrial Engrg. & Construction Co.
Irwin Foundry & Mine Car Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Kremser & Sons, Inc., Frank A.
Lamson Corp.
Link-Belt Co.
Lippmann Engineering Works
Long Co.
Manganese Steel Forge Co.
McNally Pittsburg Mfg. Corp.
Northern Conveyor Co.
Ottumwa Box Car Loader Co.
Prins & Associates K.
Richards-Wilcox Mfg. Co.
Specialty Engineering Co.
Stephens-Adamson Mfg. Co.
Transall, Inc.
Union Chain & Mfg. Co.
Washington Machinery Co.
Webb Belting & Supply Co.
Webb Co., Jervis B.
Webster Mfg., Inc.
Whitney Chain Co.
Wilmot Engineering Co.

CONVEYORS, PAN—also see Feeders, Pan

Acme Road Machinery Co.
American Conveyor Co.
Beaumont Birch Co.
Bodinson Manufacturing Co., Inc.
Christian Engineers, J. D.
Conveyor Co.
Conveyor Systems, Inc.
Denver Equipment Co.
Goodyear Tire & Rubber Co.
  Industrial Products
Gruendler Crusher & Pulverizer Co.
Helmick Foundry Machine Co.
Iowa Mfg. Co.
Jeffrey Mfg. Co.
Link-Belt Co.
Lippmann Engineering Works
Smith Engineering Works
Thompson-Starrett Co., Inc.
  Roberts & Schaefer Co. Div.

CONVEYORS, PNEUMATIC

Allen-Sherman-Hoff Co.
Beaumont Birch Co.
Convair, Inc.
Fuller Co.
General American Transportation Corp.
Gruendler Crusher & Pulverizer Co.
Lamson Corp.
Metals Disintegrating Co., Inc.
  Pulverizing Machinery Div.
Robinson Air-Activated Conveyor Systems
Spencer Turbine Co.
U. S. Hoffman Machinery Corp.
  Air Appliance Div.

CONVEYORS, MOVABLE, & PORTABLE

American Conveyor Co.
Atlas Conveyor Co.
Baldwin-Lima-Hamilton Corp.
Baldwin-Lima-Hamilton Corp. Construction Equipment Div.
Barber-Greene Co.
Baughman Manufacturing Co., Inc.
Bodinson Manufacturing Co., Inc.
Bonded Scale & Machine Co.
Carrier Conveyor Corp.
Christian Engineers, J. D.
Eimco Corp.
Food Machinery & Chemical Corp.
  Packing Equipment Div.
Hack Engineering Co.
Hapman Conveyors, Inc.
Iowa Mfg. Co.
Irwin Foundry & Mine Car Co.
Joy Mfg. Co.
Kennedy-Van Saun Mfg. & Eng. Corp.
Kremser & Sons, Inc., Frank A.
Lake Shore, Inc.
  Lake Shore Engineering Div.
Lamson Corp.
Lipnmann Engineering Works
Marsh Engineering Co., E. F.
Northern Conveyor Co.
Oliver Corp.
  A. B. Farquhar Div.
Ottumwa Box Car Loader Co.
Pettibone Mulliken Corp.
Pioneer Engineering Works, Inc.
Prins & Associates K.
Rogers Iron Works Co.
Specialty Engineering Co.
U. S. Hoffman Machinery Corp.
  Air Appliance Div.
Universal Dredge Mfg. Co.
Universal Engineering Corp.
Washington Machinery Co.
Webb Belting & Supply Co.
Williams & Green
Yuba Manufacturing Co.

CONVEYORS, SCRAPER or DRAG

Atlas Conveyor Co.
Beaumont Birch Co.
Bodinson Manufacturing Co., Inc.
Bonded Scale & Machine Co.
Christian Engineers, J. D.
Continental Gin Co.
  Industrial Div.
Conveyor Systems, Inc.
Fairmont Machinery Co.
Gruendler Crusher & Pulverizer Co.
Hapman Conveyors, Inc.
Helmick Foundry Machine Co.
Hirsch Bros. Machy. Co.
Irwin Foundry & Mine Car Co.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Kremser & Sons, Inc., Frank A.
Lamson Corp.
Link-Belt Co.
Lippmann Engineering Works
Marsh Engineering Co., E. F.
McNally Pittsburg Mfg. Corp.
Northern Conveyor Co.
Oliver Corp.
  A. B. Farquhar Div.
Ottumwa Box Car Loader Co.
Pettibone Mulliken Corp.
Prins & Associates K.
Sauerman Bros., Inc.
Specialty Engineering Co.
Stephens-Adamson Mfg. Co.
Thompson-Starrett Co., Inc.
  Roberts & Schaefer Co. Div.
Transall, Inc.
Washington Machinery Co.

Webb Belting & Supply Co.
Webb Co., Jervis B.
Webster Mfg., Inc.
Williams & Green
Wilmot Engineering Co.

CONVEYORS, SCREW OR SPIRAL

Atlas Conveyor Co.
Bartlett & Snow Co. C. O.
Baughman Manufacturing Co., Inc.
Beaumont Birch Co.
Cambridge Wire Cloth Co.
Chicago Pulley & Shafting Co.
Christian Engineers, J. D.
Continental Gin Co.
Industrial Div.
Conveyor Co.
Food Machinery & Chemical Corp.
Packing Equipment Div.
Mack Engineering Co.
Hirsch Bros. Machy. Co.
Hoffman Combustion Engineering
Holmes & Bros., Inc., Robert
Jeffrey Mfg. Co.
Kennedy-Van Saun Mfg. & Eng. Corp.
Link-Belt Co.
Lippmann Engineering Works
McNally Pittsburg Mfg. Corp.
Pioneer Engineering Works, Inc.
Prins & Associates K.
Specialty Engineering Co.
Stephens-Adamson Mfg. Co.
Sturtevant Mill Co.
Thompson-Starrett Co., Inc.
Roberts & Schaefer Co. Div.
Transall, Inc.
Universal Dredge Mfg. Co.
Washington Machinery Co.
Webb Belting & Supply Co.

CONVEYORS, SECTIONAL—also see Conveyors, Movable & Portable

Atlas Conveyor Co.
Barber-Greene Co.
Baughman Manufacturing Co., Inc.
Bonded Scale & Machine Co.
Chicago Pulley & Shafting Co.
Christian Engineers, J. D.
Continental Gin Co.
Industrial Div.
Conveyor Co.
Conveyor Systems, Inc.
Food Machinery & Chemical Corp.
Packing Equipment Div.
Gruendler Crusher & Pulverizer Co.
Hewitt-Robins, Inc.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Kramser & Sons, Inc., Frank A.
Lamson Corp.
Link-Belt Co.
Marsh Engineering Co., E. F.
Mayor & Coulson, Ltd.
McNally Pittsburg Mfg. Corp.
Northern Conveyor Co.
Ogden Iron Works
Oliver Corp.
A. B. Farquhar Div.
Ottumwa Box Car Loader Co.
Specialty Engineering Co.
Stephens-Adamson Mfg. Co.
Transall Inc.
Universal Engineering Corp.
Webb Belting & Supply Co.
Williams & Green
Yuba Manufacturing Co.

CONVEYORS, SHAKING & VIBRATING

Ajax Flexible Coupling Co.
Atlas Conveyor Co.
Cerpco Manufacturing, Inc.
Carrier Conveyor Corp.
Davis Foundry & Machine Works
Fairmont Machinery Co.
Frontier Bronze Co.
Hewitt-Robins, Inc.
Holmes & Bros., Inc., Robert
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Lecco Machinery & E gineering Co.
Link-Belt Co.
McNally Pittsburg Mfg. Corp.
Overstrom & Sons, Inc.
Ridge Equipment Co.
Simplicity Engineering Co.
Stephens-Adamson Mfg. Co.
Syntron Co.
Vulcan Iron Works
Williams & Green
Wilmot Engineering Co.

CONVEYORS, TROLLEY—also see Aerial Tramways

Forker Corp.

CONVERTERS, COPPER

Allis Chalmers Mfg. Co.
General Machinery Div.
General Electric Co.
Ind. Haulage Div.—Loco. & Car Equip. Divs.

COOLERS & CONDENSERS—also see Boilers & Heat Exchangers

Alco Products, Inc.
Allis Chalmers Mfg. Co.
General Machinery Div.
American Locomotive Co.
Bethlehem Pacific Coast Steel Corp.
Braun & Co., C. F.
Carrier Conveyor Corp.
Carrier Corp.
Chicago Pneumatic Tool Co.
Condenser Service & Engineering Co.
Corning Glass Works
Curtis Manufacturing Co.
Elliott Co.
General American Transportation Corp.
General American Transportation Corp., Louisville Dryer Div.
General Electric Co.
Ind. Haulage Div.—Loco. & Car Equip. Divs.
Gould Co., Gordon I.
Hardinge Co., Inc.
Jeffrey Mfg. Co.
Johnson Corp.
Joy Mfg. Co.
Kellogg Co., M. W.
Kennedy-Van Saun Mfg. & Eng. Corp.
Kewanee-Ross Corp.
Link-Belt Co.
Nichols Engineering & Research Corp.
Ogden Iron Works
Process Engineering, Inc.
Ross Heat Exchanger Div.
American Standard
Traylor Engineering & Mfg. Co.
Vulcan Iron Works
Western Precipitation Corp.
Wheeler Mfg. Co., C. H.
Willamette Iron & Steel Co.
Worthington Corp.

COOLING TOWERS

Binks Mfg. Co.
Carrier Corp.
Chattanooga Boiler & Tank Co.
Curtis Manufacturing Co.
Hudson Engineering Corp.
Fluor Products Co.
Foster Wheeler Corp.
Lilie-Hoffmann Cooling Towers, Inc.
Marley Co.
Pacific Wood Tank Corp.
Process Engineering, Inc.
Windeler Co., Ltd., George

COUPLERS, MINE CAR—see Car Couplers

COUPLINGS, MECHANICAL POWER TRANSMISSION—see more specific items below or Drives

COUPLINGS, M. P. T., FLEXIBLE

Ajax Flexible Coupling Co.
American Flexible Coupling Co.
Barco Mfg. Co.
Bartlett & Snow Co., C. O.
Borg-Warner Corp.
Morse Chain Co. Div.
Brown, Inc., David
Browning Mfg. Co.
Budd Inc.
Continental-Diamond Fibre Div.
Chain Belt Co.
Chicago Pulley & Shafting Co.
Chikan Co.
Christian Engineers, J. D.
Continental Gin Co.
Industrial Div.
Cullman Wheel Co.
DeLaval Steam Turbine Co.
Diamond Chain Co., Inc.
Dodge Mfg. Corp.
Dominion Engineering Co., Ltd.
Elliott Co.
F. A. B. Mfg. Co.
Falk Corp.
Farrel-Birmingham Co., Inc.
Foote Bros. Gear & Machine Corp.
Graton & Knight Co.
Jeffrey Mfg. Co.
Jones Foundry & Machine Co., W. A.
Koppers Co., Inc.
Koppers Co., Inc.
Metal Prod. Div.
Link-Belt Co.
Lovejoy Flexible Coupling Co.
National Motor Bearings
Arrowhead Rubber Co. Div.
New York Belting & Packing Co.
Poole Foundry & Machine Co.
Smith & Sarrell, Inc.
Thomas Flexible Coupling Co.
Transall, Inc.
Union Chain & Mfg. Co.
Waldron Corp., John
Webb Belting & Supply Co.
Western Gear Corp.
Whitney Chain Co.
Wood's Sons Co., T. B.

COUPLINGS, M. P. T., FLUID—also see Drives, Fluid

American Blower Corp.
(Div. American-Standard)
American Flexible Coupling Co.
Barco Mfg. Co.
Dodge Mfg. Corp.
Foote Bros. Gear & Machine Corp.
Link-Belt Co.
National Motor Bearings
Arrowhead Rubber Co. Div.
Transall, Inc.
Twin Disc Clutch Co.
Weatherhead Co.
Fort Wayne Div.

COUPLINGS, M. P. T., RIGID

Browning Mfg. Co.
Chicago Pulley & Shafting Co.
Continental Gin Co.
Industrial Div.
Dodge Mfg. Corp.
Farrel-Birmingham Co., Inc.
Foote Bros. Gear & Machine Corp.
Koppers Co., Inc.
Metal Prod. Div.
Link-Belt Co.
Transall, Inc.
Waldron Corp., John
Western Gear Corp.
Wilmot Engineering Co.
Wood's Sons Co., T. B.

CRANES, CRAWLER, LOCOMOTIVE & WHEELED

American Hoist & Derrick Co.
Austin-Western Works
Construction Equipment Div.
Baldwin-Lima-Hamilton Corp.
Baker Raulang Co.
Baldwin-Lima-Hamilton Corp.
Construction Equipment Div.
Bay City Shovels, Inc.
Bucyrus-Erie Co.
Clark Equipment Co.
Construction Machinery Div.
Dominion Engineering Co., Ltd.
Gar Wood Industries, Inc.
Harnischfeger Corp.
P & H Diesel Div.
Hendrickson Mfg. Co.
Hyster Co.
Industrial Brownhoist Corp.
Insley Manufacturing Corp.
Koehring Co.
Le Tourneau-Westinghouse Co.
Link-Belt Speeder Corp.
Little Giant Crane & Shovel Co.
Marion Power Shovel Co.
Maxi Corp.
McDowell Co.
Dwight-Lloyd Div.
Northwest Engineering Co.
Ohio Locomotive Crane Co.
Pitman Manufacturing Co.
Quick-Way Truck Shovel Co.
Schield Bantam Co.
Silent Hoist & Crane Corp.
Thew Shovel Co.
Unit Crane & Shovel Corp.
Wellman Engineering Co.
McDowell Enterprise

CRANES, JIB

Chisholm-Moore Hoist Corp.
Clark Equipment Co.
Construction Machinery Div.
Conco Engineering Works
Detroit Hoist & Machine Co.
Le Tourneau-Westinghouse Co.
Little Giant Crane & Shovel Co.
Magnus, Inc., W. R.
Ohio Hoist & Mfg. Co., Inc.
Richards-Wilcox Mfg. Co.
Schield Bantam Co.
Shepard Niles Crane & Hoist Corp.
Whiting Corp.

CRANES, OVERHEAD-TRAVELING, GANTRY & BRIDGE

American Chain & Cable Co., Inc.
Wright Hoist Div.
Cleveland Crane & Engrg. Co.
Clyde Iron Works, Inc.
Conco Engineering Works
DeLong Engineering Corp.
Detroit Hoist & Machine Co.
Dravo Corp.
Forker Corp.
Hack Engineering Co.
Harnischfeger Corp.
P & H Diesel Div.
Heyl & Patterson, Inc.
Lakeside Bridge & Steel Co.
Louden Machinery Co.
Manitowoc Engineering Corp.
Manning, Maxwell & Moore, Inc.
Shaw Box Crane & Hoist Div.
Ohio Hoist & Mfg. Co., Inc.
Reading Crane & Hoist Corp.
Richards-Wilcox Mfg. Co.
Robbins & Myers, Inc.
Round & Son, Inc., David
Shepard Niles Crane & Hoist Corp.
Union Iron Works
Universal Dredge Mfg. Co.
Webb Co., Jervis B.
Wellman Engineering Co.
McDowell Enterprise
Whiting Corp.
Willamette Iron & Steel Co.

CRUSHER PARTS

Acme Road Machinery Co.
Allis Chalmers Mfg. Co.
General Machinery Div.
Alloy Steel & Metals Co.
American Brake Shoe Co.
American Brake Shoe Co.
American Steel Div.
American Forge Co.
American Steel Foundries
Baldwin-Lima-Hamilton Corp.
Standard Steel Works Div.
Bico, Inc.
Birdsboro Steel Foundry & Machine Co.
Denver Equipment Co.
Electric Steel Foundry Co.
Farrell-Cheek Steel Co.
Gatke Corp.
Heyl & Patterson, Inc.
Industrial Overlay Metals, Inc.
Iowa Mfg. Co.
Jeffrey Mfg. Co.
Kensington Steel Co.
Lippmann Engineering Works
Maddox Foundry & Machine Works, Inc.
McNally Pittsburg Mfg. Corp.
Nordberg Mfg. Co.
Pennsylvania Crusher Div.
Bath Iron Works Corp.
Pettibone Mulliken Corp.
Pioneer Engineering Works, Inc.
Smith Engineering Works
Sorel Steel Foundries, Ltd.
Straub Mfg. Co.
Stroh Process Steel Co.
Taylor-Wharton Co. Div.
Harsco Corp.
Thomas Foundries, Inc.
Traylor Engineering & Mfg. Co.
Universal Engineering Corp.
Williams & Green

CRUSHERS, CONE

Acme Road Machinery Co.
Allis Chalmers Mfg. Co.
General Machinery Div.
Fahrenwald Co., A. W.
Iowa Mfg. Co.
Lippmann Engineering Works
Maddox Foundry & Machine Works, Inc.
McFarlane-Eggers Machinery Co.
Nordberg Mfg. Co.
Pennsylvania Crusher Div.
Bath Iron Works Corp.
Smith Engineering Works
Straub Mfg. Co.
Universal Engineering Corp.
Williams & Green

CRUSHERS, DISC—also see Pulverizers

Braun Corp.
Denver Fire Clay Co.
Hewitt-Robins, Inc.
Holmes & Bros., Inc., Robert
Nordberg Mfg. Co.
Sturtevant Mill Co.
Williams & Green

CRUSHERS, GYRATORY

Allis Chalmers Mfg. Co.
General Machinery Div.
Fahrenwald Co., A. W.
Joy Mfg. Co.
Kennedy-Van Saun Mfg. & Eng. Corp.
Lippmann Engineering Works
Nordberg Mfg. Co.
Pennsylvania Crusher Div.
Bath Iron Works Corp.
Smith Engineering Works
Stearns Roger Mfg. Co.
Straub Mfg. Co.
Traylor Engineering & Mfg. Co.

CRUSHERS, HAMMER

Acme Road Machinery Co.
Allis Chalmers Mfg. Co.
General Machinery Div.
American Pulverizer Co.
Bartlett & Snow Co., C. O.
Gruendler Crusher & Pulverizer Co.
Holmes & Bros., Inc., Robert
Iowa Mfg. Co.
Jeffrey Mfg. Co.
Lippmann Engineering Works
Metals Disintegrating Co., Inc.
Pulverizing Machinery Div.
Pennsylvania Crusher Div.
Bath Iron Works Corp.
Pettibone Mulliken Corp.
Pioneer Engineering Works, Inc.
Rogers Iron Works Co.
Smith Engineering Works
Sturtevant Mill Co.
Universal Engineering Corp.
Williams Patent Crusher & Pulverizer Co.

CRUSHERS, IMPACT
Acme Road Machinery Co.
Allis Chalmers Mfg. Co. General Machinery Div.
Athey Products Corp.
Gruendler Crusher & Pulverizer Co.
Hazemag-MBH
Jeffrey Mfg. Co.
Kennedy-Van Saun Mfg. & Eng. Corp.
Lippmann Engineering Works
Metals Disintegrating Co., Inc. Pulverizing Machinery Div.
Nordberg Mfg. Co.
Pennsylvania Crusher Div. Bath Iron Works Corp.
Pettibone Mulliken Corp.
Smith Engineering Works
Universal Engineering Corp.
Williams & Green
Williams Patent Crusher & Pulverizer Co.

CRUSHERS, JAW
Acme Road Machinery Co.
Allis Chalmers Mfg. Co. General Machinery Div.
Alloy Steel & Metals Co.
Bacon-Greene & Milroy
Baldwin-Lima-Hamilton Corp. Construction Equipment Div.
Bico, Inc.
Birdsboro Steel Foundry & Machine Co.
Buffalo Hammer Mill Corp.
Denver Equipment Co.
Diamond Iron Works Div. Goodman Mfg. Co.
Dominion Engineering Co., Ltd.
Fahrenwald Co., A. W.
Farrel-Birmingham Co., Inc.
Gruendler Crusher & Pulverizer Co.
Iowa Mfg. Co.
Jeffrey Mfg. Co.
Kennedy-Van Saun Mfg. & Eng. Corp.
Lippmann Engineering Works
McLanahan & Stone Corp.
Morse Bros. Machinery Co.
Pennsylvania Crusher Div. Bath Iron Works Corp.
Pettibone Mulliken Corp.
Pioneer Engineering Works, Inc.
Rogers Iron Works Co.
Smith Engineering Works
Stearns Roger Mfg. Co.
Straub Mfg. Co.
Stroh Process Steel Co.
Sturtevant Mill Co.
Traylor Engineering & Mfg. Co.
Universal Engineering Corp.
Universal Road Machinery Co.
Williams & Green

CRUSHERS, PORTABLE & MOVABLE
Acme Road Machinery Co.
Allen-Sherman-Hoff Co.
Baldwin-Lima-Hamilton Corp. Construction Equipment Div.
Bico, Inc.
Bonded Scale & Machine Co.
Denver Equipment Co.
Diamond Iron Works Div. Goodman Mfg. Co.
Gruendler Crusher & Pulverizer Co.
Joy Mfg. Co.
Kennedy-Van Saun Mfg. & Eng. Corp.
Lippmann Engineering Works
Nordberg Mfg. Co.
Pettibone Mulliken Corp.
Pioneer Engineering Works, Inc.
Rogers Iron Works Co.
Smith Engineering Works
Straub Mfg. Co.
Universal Engineering Corp.
Universal Road Machinery Co.
Williams & Green
Williams Patent Crusher & Pulverizer Co.

CRUSHERS, RING
American Pulverizer Co.
Buffalo Hammer Mill Corp.
Gruendler Crusher & Pulverizer Co.
Jeffrey Mfg. Co.
Pennsylvania Crusher Div. Bath Iron Works Corp.
Simplicity Engineering Co.
Smith Engineering Works
Stephens-Adamson Mfg. Co.
Sturtevant Mill Co.
Williams & Green
Williams Patent Crusher & Pulverizer Co.

CRUSHERS, ROLL
Acme Road Machinery Co.
Allen-Sherman-Hoff Co.
Allis Chalmers Mfg. Co. General Machinery Div.
Bacon-Greene & Milroy
Baldwin-Lima-Hamilton Corp. Construction Equipment Div.
Bartlett & Snow Co., C. O.
Birdsboro Steel Foundry & Machine Co.
Bonded Scale & Machine Co.
Diamond Iron Works Div. Goodman Mfg. Co.
Exolon Co.
Gruendler Crusher & Pulverizer Co.
Hewitt-Robins, Inc.
Heyl & Patterson, Inc.
Gundlach Machine Co., T. J. Div. of JMJ Industries, Inc.
Iowa Mfg. Co.
Jeffrey Mfg. Co.
Kennedy-Van Saun Mfg. & Eng. Corp.
Link-Belt Co.
Lippmann Engineering Works
Maddox Foundry & Machine Works, Inc.
McFarlane-Eagers Machinery Co.
McLanahan & Stone Corp.
McNally Pittsburg Mfg. Corp.
Metals Disintegrating Co., Inc. Pulverizing Machinery Div.
Pennsylvania Crusher Div. Bath Iron Works Corp.
Pettibone Mulliken Corp.
Pioneer Engineering Works, Inc.
Rogers Iron Works Co.
Smith Engineering Works
Stephens-Adamson Mfg. Co.
Sturtevant Mill Co.
Traylor Engineering & Mfg. Co.
Universal Engineering Corp.
Williams & Green
Williams Patent Crusher & Pulverizer Co.
Wilmot Engineering Co.

CUTTING MACHINE BITS
Bowdil Co.
Carboloy Dept. General Electric Co.
Cincinnati Mine Machinery Co. Mining Div.
Firth Sterling, Inc.
Kennametal Inc.
Marathon Coal Bit Co.
National Mine Service Co.
Newcomer Products, Inc.
Willey's Carbide Tool Co.

CUTTING MACHINE PARTS
Bowdil Co.
Brad Foote Gear Works Pittsburgh Gear Co. Div.
Cincinnati Mine Machinery Co. Mining Div.
Flood City Brass & Elec. Co.
Joy Mfg. Co.
Precision Chain Co.
West Virginia Armature Co.

CUTTING MACHINES—also see Continuous Miners & Planers
Dominion Engineering Co., Ltd.
Joy Mfg. Co.
Mavor & Coulson, Ltd.
National Cylinder Gas Co.
Union Carbide & Carbon Corp. Linde Air Products Co. Div.
Victor Equipment Co.

CYANIDE—see Chemicals

CYANIDE PLANTS
Denver Equipment Co.
Dorr Oliver, Inc.
Morse Bros. Machinery Co.
Traylor Engineering & Mfg. Co.
Western Machinery Co.

CYCLONES—see Classifiers, Cyclone

CYLINDERS, AIR & HYDRAULIC
American-Marsh Pumps, Inc.
Blackhawk Mfg. Co.
Card Iron Works, C. S.
Cessna Aircraft Co.
Commercial Shearing & Stamping Inc.
Curtis Manufacturing Co.
Galland Henning Mfg. Co. Nopak Div.
Gar Wood Industries, Inc.
Heil Co.
Hockensmith Corp.
Kelloga Co., M. W.
Ledeen Mfg. Co.
National Iron Co.
New York Air Brake Co. Hydraulic Div.
Oilgear Co.
Owatonna Tool Co.
Sheppard Co., Inc., R. H.
Vickers, Inc.
Wellman Engineering Co. McDowell enterprise
Westinghouse Air Brake Co. Ind. Products Div.

DENSITY CONTROLLERS—see Meters, Liquid (& Slurry) Density

DIAMONDS, INDUSTRIAL
American Coldset Corp.
Antwerp Industrial Diamond Co.
Diamond Drill Carbon Co.
Hoffman Brothers Drilling & Mfg. Co.
Houston Tool Co., Inc.
International General Electric Co.
Koebel Diamond Tool Co.
Patrick, Inc., R. S.
Smit & Co., Anton
Sprague & Henwood, Inc.
Snyder Mine & Chemical Lab.
Wheel Trueing Tool Co.

DIPPER SHOVELS—also see Buckets, Dipper Shovel
Harnischfeger Corp. P & H Diesel Div.
Little Giant Crane & Shovel Co.

DRAFTING EQUIPMENT & SUPPLIES—also see Blue, Photo; White Print Machines
Brunning Co., Inc., Charles
Elliott Co., B. K.
Geo-Optic Co., Inc.
Gerber Scientific Instrument Co.
Keuffel & Esser Co.
Pease Co., C. F.
Post Co., Frederick

DRAGLINES—also see Buckets, Dragline
American Hoist & Derrick Co.
American Steel Dredge Co.
Baldwin-Lima-Hamilton Corp. Construction Equipment Div.
Bay City Shovels, Inc.
Bucyrus-Erie Co.
Colorado Fuel & Iron Corp.
Dominion Engineering Co., Ltd.
Harnischfeger Corp. P & H Diesel Div.
Insley Manufacturing Corp.
Link-Belt Speeder Corp.
Little Giant Crane & Shovel Co.
Manitowoc Engineering Corp.
Marion Power Shovel Co.
Northwest Engineering Co.
Page Engineering Co.
Quick-Way Truck Shovel Co.
Schield Bantam Co.
Sorel Steel Foundries, Ltd.
Thew Shovel Co.
Unit Crane & Shovel Corp.

DREDGE HULLS
American Steel Dredge Co.
Bethlehem Pacific Coast Steel Corp.
Bodinson Manufacturing Co., Inc.
Dravo Corp.
Ellicott Machine Corp.
Graver Tank & Mfg. Co., Inc.
Hack Engineering Co.
Meckum Engineering, Inc.
New York Engineering Co.
Pacific Coast Engineering Co.
Union Iron Works
Universal Dredge Mfg. Co.
Wiley Mfg. Co.
Yaun Mfg. Co., Inc.
Yuba Manufacturing Co.

DREDGE SLEEVES
American Rubber Mfg. Co.
Carlyle Rubber Co.
Ellicott Machine Corp.
Goodrich Industrial Products Co., B. F.
Hamilton Rubber Mfg. Corp.
Hewitt-Robins Inc.
Morris Machine Works
Porter Co., Inc., H. K.
Quaker Pioneer Rubber Div.
Raybestos-Manhattan, Inc. Manhattan Rubber Div.

DREDGES, BUCKETLINE—also see Buckets, Bucketline Dredge
American Steel Dredge Co.
Bethlehem Pacific Coast Steel Corp.
Dravo Corp.
Ellicott Machine Corp.
Georgia Iron Works Co.
Maddox Foundry & Machine Works, Inc.
Morris Machine Works
New York Engineering Co.
Yuba Manufacturing Co.

DREDGES, DIPPER SHOVEL—also see Buckets, Dipper Shovel
American Brake Shoe Co. American Steel Div.
American Steel Dredge Co.
Dravo Corp.
Ellicott Machine Corp.
Georgia Iron Works Co.
Maddox Foundry & Machine Works, Inc.
Morris Machine Works
Stearns Roger Mfg. Co.

DREDGES, SUCTION
American Brake Shoe Co. American Steel Div.
American Steel Dredge Co.
Bethlehem Pacific Coast Steel Corp.
Eagle Iron Works
Ellicott Machine Corp.
Georgia Iron Works Co.
Hack Engineering Co.
Maddox Foundry & Machine Works, Inc.
Meckum Engineering, Inc.
Morris Machine Works
Pacific Coast Engineering Co.
Universal Dredge Mfg. Co.
Yuba Manufacturing Co.

DRILLS, HAND, PORTABLE ELECTRIC—see Tools, hand, power

DRILLS (ROCK & EARTH), AUGER
Acker Drill Co.
Cardox Corp. Hardsocg Div.
Chicago Pneumatic Tool Co.
Compton, Inc.
Dooley Brothers
Gardner-Denver Co.
Hoffman Brothers Drilling & Mfg. Co.
Houston Tool Co., Inc.
Howells Mining Drill Co.
Leetonia Tool Co.
Mayhew Machine & Supply Co.
Mobile Drilling, Inc.
New York Engineering Co.
Salem Tool Co.
Schramm, Inc.
Stardrill-Keystone Co.
Thor Power Tool Co.
Westinghouse Air Brake Co.
Winter Weiss Co.
Worthington Corp.

DRILLS (ROCK), CHURN
Acme Fishing Tool Co. Div. Stardrill-Keystone Co.
Bucyrus-Erie Co.
Consolidated Diamond Drill Corp., Ltd.
Hossfeld Mfg. Co.
Moore & Siegal
Sanderson Cyclone Drill Co.
Spang & Co.
Stardrill-Keystone Co.
Winter-Weiss Co.

DRILLS (ROCK), CORE
Acker Drill Co.
Consolidated Diamond Drill Corp., Ltd.
Davey Compressor Co.
Diamond Drill Carbon Co.
Drullard Co., Howard
Gardner-Denver Co.
Hoffman Brothers Drilling & Mfg. Co.
Joy Mfg. Co.
Koebel Diamond Tool Co.
Sprague & Henwood, Inc.
Westinghouse Air Brake Co.
Westinghouse Air Brake Co. Le Roi Div.
Winter Weiss Co.

DRILLS (ROCK), DIAMOND
Acker Drill Co.
American Coldset Corp.
Boyles Bros. Drilling Co., Ltd. (Vancouver)
Chicago Pneumatic Tool Co.
Consolidated Diamond Drill Corp., Ltd.
Diamond Drill Carbon Co.
Diamond Drill Contracting Co.
Drilling Accessory & Mfg. Co., Inc.
Gunderson-Taylor Machine Co.
Havlick, J. L.
Hoffman Brothers Drilling & Mfg. Co.
Houston Tool Co., Inc.
Joy Mfg. Co.
Koebel Diamond Tool Co.
Longyear Co., E. J.
Mayhew Machine & Supply Co.
McClintock Co., R. S.
Metal Carbides Corp.
Mott Core Drilling Co.
Packsack Diamond Drills Limited
Pennsylvania Drilling Co.
Salem Tool Co.
Sprague & Henwood, Inc.
Stardrill-Keystone Co.
Westinghouse Air Brake Co. Le Roi Div.
Westinghouse Air Brake Co.
Wheel Trueing Tool Co.

DRILLS (ROCK), FLAME & JET PIERCING
Bucyrus-Erie Co.
Union Carbide & Carbon Corp. Linde Air Products Co. Div.

DRILLS (ROCK), PERCUSSION
Acme Fishing Tool Co. Div. Stardrill-Keystone Co.
Atlas Copco Eastern, Inc.
Barco Mfg. Co.
Bucyrus-Erie Co.
Chicago Pneumatic Tool Co.
Davey Compressor Co.
Gardner, Denver Co.
Holman Bros. (Canada), Ltd.
Houston Tool Co., Inc.
Ingersoll-Rand Co.

Joy Mfg. Co.
Maschinenfabrik Rudolf Hausherr & Soehne, GmbH
c/o B. J. Nykerk Co.
Mayhew Machine & Supply Co.
Reed Roller Bit Co.
Sanderson Cyclone Drill Co.
Schramm, Inc.
Spang & Co.
Stardrill-Keystone Co.
Westinghouse Air Brake Co.
Cleveland Rock Drill Plant, Le Roi Div.
Worthington Corp.

DRILLS (ROCK), PORTABLE, GASOLINE & DIESEL
Atlas Copco Eastern, Inc.
Atlas Copco Pacific, Inc.
Barco Mfg. Co.
Cardox Corp.
Hardsocg Div.
Chicago Pneumatic Tool Co.
Davey Compressor Co.
Hossfeld Mfg. Co.
Houston Tool Co., Inc.
Joy Mfg. Co.
Longyear Co., E. J.
Mayhew Machine & Supply Co.
Salem Tool Co.
Stardrill-Keystone Co.
Syntron Co.

DRILLS (ROCK), ROTARY, QUARRY & WELL
Bucyrus-Erie Co.
Cardox Corp.
Hardsocg Div.
Chicago Pneumatic Tool Co.
Davey Compressor Co.
Drilling Accessory & Mfg. Co., Inc.
Failing Co., George E.
Houston Tool Co., Inc.
Ingersoll-Rand Co.
Joy Mfg. Co.
Longyear Co., E. J.
Maschinenfabrik Rudolf Hausherr & Soehne, GmbH
c/o B. J. Nykerk Co.
Mayhew Machine & Supply Co.
Reich Bros. Mfg. Co.
Salem Tool Co.
Sanderson Cyclone Drill Co.
Schramm, Inc.
Stardrill-Keystone Co.
Thor Power Tool Co.
Westinghouse Air Brake Co.
Westinghouse Air Brake Co.
Le Roi Div.
Winter Weiss Co.
Worthington Corp.

DRILLS (ROCK), ROTARY, SMALL HOLE
Atlas Copco Pacific, Inc.
Bucyrus-Erie Co.
Chicago Pneumatic Tool Co.
Davey Compressor Co.
Houston Tool Co., Inc.
Joy Mfg. Co.
Longyear Co., E. J.
Maschinenfabrik Rudolf Hausherr & Soehne GmbH
c/o B. J. Nykerk Co.
Mayhew Machine & Supply Co.
Reed Roller Bit Co.
Salem Tool Co.
Schramm, Inc.
Star Expansion
Stardrill-Keystone Co.
Thor Powsr Tool Co.
Varel Mfg. Co.
Westinghouse Air Brake Co.
Westinghouse Air Brake Co.
Le Roi Div.
Wheel Trueing Tool Co.
Worthington Corp.

DRILLS (ROCK), WAGON
Chicago Pneumatic Tool Co.
Gardner-Denver Co.
Holman Bros. (Canada), Ltd.
Howells Mining Drill Co.
Ingersoll-Rand Co.
Joy Mfg. Co.
Minerals Engineering Co.
Schramm, Inc.
Thor Power Tool Co.
Westinghouse Air Brake Co.
Westinghouse Air Brake Co.
Cleveland Rock Drill Plant, Le Roi Div.
Winter-Weiss Co.
Worthington Corp.

DRILL (ROCK) BITS, AUGER
Acker Drill Co.
Cardox Corp.
Hardsocg Div.
Central Mine Equipment Co.
Compton, Inc.
Dooley Brothers
Firth Sterling, Inc.
Gardner-Denver Co.
Carboloy Dept.
General Electric Co.
Hales Co., W. M.
Howells Mining Drill Co.
Kennametal Inc.
Leetonia Tool Co.
Marathon Coal Bit Co.
Mayhew Machine & Supply Co.
Milwaukee Electric Tool Corp.
Mobile Drilling, Inc.
Salem Tool Co.
Thor Power Tool Co.
Vascoloy-Ramet Corp.
Worthington Corp.

DRILL (ROCK) BITS, CHURN
Acme Fishing Tool Co. Div.
Stardrill-Keystone Co.
Brunner & Lay Rock Bit of Philadelphia, Inc.
Bucyrus-Erie Co.
Sanderson Cyclone Drill Co.
Spang & Co.
Stardrill-Keystone Co.
United States Steel Corp.

DRILL (ROCK) BITS, CORE
Acker Drill Co.
Boyles Bros. Drilling Co., Ltd. (Vancouver)
Chicago Pneumatic Tool Co.
Christensen Diamond Products Co.
Consolidated Diamond Drill Corp., Ltd.
Diamond Drill Carbon Co.
Diamond Drill Contracting Co.
Diamond Products, Inc.
Drilling Accessory & Mfg. Co., Inc.
Failing Co., George E.
Hoffman Brothers Drilling & Mfg. Co.
Houston Tool Co., Inc.
Joy Mfg. Co.
Kennametal Inc.
Koebel Diamond Tool Co.
Longyear Co., E. J.
Mayhew Machine & Supply Co.
McClintock Co., R. S.
Mott Core Drilling Co.
Pennsylvania Drilling Co.
Reed Roller Bit Co.
Salem Tool Co.
Sprague & Henwood, Inc.
Star Expansion
Stardrill-Keystone Co.
Westinghouse Air Brake Co.
Westinghouse Air Brake Co.
Le Roi Div.

DRILL (ROCK) BITS, DIAMOND
Acker Drill Co.
American Coldset Corp.
Boyles Bros. Drilling Co., Ltd. (Vancouver)
Chicago Pneumatic Tool Co.
Christensen Diamond Products Co.
Consolidated Diamond Drill Corp., Ltd.
Diamond Drill Carbon Co.
Diamond Drill Contracting Co.
Diamond Products, Inc.
Drilling Accessory & Mfg. Co., Inc.
Failing Co., George E.
Havlick, J. L.
Hoffman Brothers Drilling & Mfg. Co.
Houston Tool Co., Inc.
Joy Mfg. Co.
Koebel Diamond Tool Co.
Longyear Co., E. J.
Mayhew Machine & Supply Co.
McClintock Co., R. S.
Metal Carbides Corp.
Mott Core Drilling Co.
Pennsylvania Drilling Co.
Salem Tool Co.
Smit & Co., Anton
Smit & Sons, Inc., J. K.
Sprague & Henwood, Inc.
Stardrill-Keystone Co.
Snyder Mine & Chemical Lab.
Varel Mfg. Co.
Wheel Trueing Tool Co.

DRILL (ROCK) BITS, DIAMOND, RESETTING SERVICE
Acker Drill Co.
American Coldset Corp.
Boyles Bros. Drilling Co., Ltd. (Vancouver)
Christensen Diamond Products Co.
Consolidated Diamond Drill Corp., Ltd.
Diamond Drill Carbon Co.
Diamond Products, Inc.
Drilling Accessory & Mfg. Co., Inc.
Havlick, J. L.
Hoffman Brothers Drilling & Mfg. Co.
Joy Mfg. Co.
Koebel Diamond Tool Co.
Longyear Co., E. J.
Mayhew Machine & Supply Co.
McClintock Co., R. S.
Metal Carbides Corp.
Pennsylvania Drilling Co.
Smit & Co., Anton
Smit & Sons, Inc., J. K.
Sprague & Henwood, Inc.
Stardrill-Keystone Co.
Wheel Trueing Tool Co.

DRILL (ROCK) BITS, PERCUSSION
Acme Fishing Tool Co. Div.
Stardrill-Keystone Co.
Atlas Copco Eastern, Inc.
Brunner & Lay Rock Bit of Philadelphia, Inc.
Bucyrus-Erie Co.
Chicago Pneumatic Tool Co.
Firth Sterling, Inc.
Gardner-Denver Co.
Holman Bros. (Canada), Ltd.
Houston Tool Co., Inc.
Ingersoll-Rand Co.
Joy Mfg. Co.
Kennametal Inc.
Minerals Engineering Co.
Reed Roller Bit Co.
Sanderson Cyclone Drill Co.
Star Expansion
Stardrill-Keystone Co.
Thompson Products, Ltd.
Throwaway Bit Corp.
Timken Roller Bearing Co.
Vascoloy-Ramet Corp.
Western Rock Bit Mfg. Co.
Westinghouse Air Brake Co.
Westinghouse Air Brake Co.
Cleveland Rock Drill Plant, Le Roi Div.
Worthington Corp.

DRILL (ROCK) BITS, ROTARY, QUARRY & WELL
Cardox Corp.
Hardsocg Div.
Central Mine Equipment Co.
Drilling Accessory & Mfg. Co., Inc.
Failing Co., George E.
Firth Sterling, Inc.
Hawthorne, Inc., Herb J.
Houston Tool Co., Inc.
Howells Mining Drill Co.
Hughes Tool Co.
Industrial Overlay Metals, Inc.
Longyear Co., E. J.
Mayhew Machine & Supply Co.
Moore & Siegal
Reed Roller Bit Co.
Stardrill-Keystone Co.
Thor Power Tool Co.
Vascoloy-Ramet Corp.
Varel Mfg. Co.
Worthington Corp.

DRILL (ROCK) BITS, ROTARY, SMALL HOLE
Atlas Copco Pacific, Inc.
Drilling Accessory & Mfg. Co., Inc.
Firth Sterling, Inc.
Hawthorne, Inc., Herb J.
Houston Tool Co., Inc.
Howells Mining Drill Co.
Kennametal Inc.
Longyear Co., E. J.
Mayhew Machine & Supply Co.
Reed Roller Bit Co.
Star Expansion
Stardrill-Keystone Co.
Thor Power Tool Co.
Varel Mfg. Co.
Vascoloy-Ramet Corp.
Westinghouse Air Brake Co.
Westinghouse Air Brake Co.
Le Roi Div.
Worthington Corp.

DRILL (ROCK) BIT & STEEL SHARPENERS
Atlas Copco Pacific, Inc.
Blount Co. J. G.
Bucyrus-Erie Co.
Chicago Pneumatic Tool Co.
Coeur d'Alene Hardware & Foundry Co.
Gardner-Denver Co.
Ingersoll-Rand Co.
Mine & Smelter Supply Co.
Marcy Mill Div.
Thor Power Tool Co.

DRILL (ROCK) CORE BARRELS
Acker Drill Co.
American Coldset Corp.
Boyles Bros. Drilling Co., Ltd. (Vancouver)
Chicago Pneumatic Tool Co.
Christensen Diamond Products Co.
Consolidated Diamond Drill Corp., Ltd.
Davey Compressor Co.
Diamond Drill Contracting Co.
Drilling Accessory & Mfg. Co., Inc.
Failing Co., George E.
Hoffman Brothers Drilling & Mfg. Co.
Houston Tool Co., Inc.
Joy Mfg. Co.
Longyear Co., E. J.
Mayhew Machine & Supply Co.
McClintock Co., R. S.
Minerals Engineering Co.
Mott Core Drilling Co.
Pennsylvania Drilling Co.
Reed Roller Bit Co.
Sprague & Henwood, Inc.

DRILL (ROCK) JUMBOS
Acme Machinery Co.
Chicago Pneumatic Tool Co.
Coeur d'Alene Hardware & Foundry Co.
Gardner-Denver Co.
Ingersoll-Rand Co.
Joy Mfg. Co.
Maschinenfabrik Rudolf Hausherr & Soehne, GmbH
c/o B. J. Nykerk Co.
Mayo Tunnel & Mine Equipment Co.
Rogers Iron Works Co.
Thor Power Tool Co.
Westinghouse Air Brake Co.
Westinghouse Air Brake Co.
Cleveland Rock Drill Plant, Le Roi Div.

DRILL (ROCK) REAMING STRIPS & SHELLS
Acker Drill Co.
Boyles Bros. Drilling Co., Ltd. (Vancouver)
Christensen Diamond Products Co.
Consolidated Diamond Drill Corp., Ltd.
Diamond Drill Carbon Co.
Diamond Products, Inc.
Drilling Accessory & Mfg. Co., Inc.
Joy Mfg. Co.
McClintock Co., R. S.
Metal Carbides Corp.
Pennsylvania Drilling Co.
Wheel Trueing Tool Co.

DRILL (ROCK) STEEL
Acme Machinery Co.
Atlas Copco Eastern, Inc.
Atlas Copco Pacific, Inc.
Atlas Steels, Ltd.
Bethlehem Pacific Coast Steel Corp.
Bethlehem Steel Co., Inc.
Black's Machine Shop
Brunner & Lay Rock Bit of Philadelphia, Inc.
Carpenter Steel Co.
Coeur d'Alene Hardware & Foundry Co.
Crucible Steel Co. of America
Hisey-Wolf Machine Co.
Houston Tool Co., Inc.
Howells Mining Drill Co.
Hoyland Steel Co.
Ingersoll-Rand Co.
Joy Mfg. Co.
Marathon Coal Bit Co.
Minerals Engineering Co.
Reed Roller Bit Co.
Sheffield Steel Div.
Armco Steel Corp.
Thor Power Tool Co.
Westinghouse Air Brake Co.
Le Roi Div.
DRILL STEEL SHARPENERS—see Drill Bit & Steel Sharpeners

DRILLING CONTRACTORS—also see Searchlight Section
Boyles Bros. Drilling Co., Inc. (Utah)
Boyles Bros. Drilling Co., Ltd. (Vancouver)
Consolidated Diamond Drill Corp., Ltd.
Havlick Diamond Drilling Co., Inc.
Hoffman Brothers Drilling & Mfg. Co.
Joy Mfg. Co.
Judd & Son, J. D.
Manu-Mine Research & Devel. Co.
McClintock Co. R. S.
McDonald Drilling Co., Inc.
McKinney Drilling Co.
Minerals Engineering Co.
Mott Core Drilling Co.
Pennsylvania Drilling Co.
Sprague & Henwood, Inc.
Southeastern Diamond Drilling Co.
Tinney Drilling Co.

DRIVES, MECHANICAL POWER TRANSMISSION—see specific type below; also see Clutches; or Couplings

DRIVES, BELT
American Pulley Co.
Barber-Greene Co.
Browning Mfg. Co.
Chicago Pulley & Shafting Co.
Christian Engineers, J. D.
Conveyor Co.
Dodge Mfg. Corp.
Fisher Leather Belting Co., Inc.
Gates Rubber Co.
Gilmer Co., L. H.
Hewitt-Robins, Inc.
Jones Foundry & Machine Co., W. A.
Joy Mfg. Co.
Lovejoy Flexible Coupling Co.
McNally Pittsburg Mfg. Corp.
National Iron Co.
New York Belting & Packing Co.
Thor Power Tool Co.
Transall, Inc.
Williams, I. B. & Sons

DRIVES, CHAIN
Borg-Warner Corp.
Morse Chain Co. Div.
Chain Belt Co.
Christian Engineers, J. D.
Diamond Chain Co., Inc.
Hirsch Bros. Machy. Co.
Union Chain & Mfg. Co.

DRIVES, FLUID
American Blower Corp.
(Div. American-Standard)
Clark Equipment Co.
Transmission Div.
Dodge Mfg. Corp.
General Motors Corp.
Allison Div.
Hewitt-Robins, Inc.
Link-Belt Co.
National Supply Co.
Rockwell Spring & Axle Co.
Timken-Detroit Axle Div.
Schroeder Brothers
Sheppard Co., Inc., R. H.
Transall Inc.
Twin Disc Clutch Co.
Western Gear Corp.

DRIVES, GEAR
Allis Co., Louis
Barber-Greene Co.
Blaw-Knox Co.
Brad Foote Gear Works
Brown, Inc., David
Chicago Pulley & Shafting Co.
Christian Engineers, J. D.
Cleveland Worm & Gear Co.
Cone-Drive Gears Div.
Michigan Tool Co.
Dominion Engineering Co., Ltd.
Falk Corp.
Farrel-Birmingham Co., Inc.
Foote Bros. Gear & Machine Corp.
Hewitt-Robins, Inc.
Jones Foundry & Machine Co., W. A.
Kanawha Mfg. Co.
Lima Electric Motor Co.
Link-Belt Co.
McNally Pittsburg Mfg. Corp.
Michigan Tool Co.
Cone Drive Gear Div.
National Iron Co.
Ohio Gear Co.
Sterling Electric Motors, Inc.
Transall Inc.
U. S. Electrical Motors, Inc.
Voland & Sons, Inc.
Washington Machinery Co.
Webb Co., Jervis B.
Western Gear Corp.
Wilmot Enninеering Co.

DRIVES, MAGNETIC
Allis Co., Louis
Dynamatic Div.
Eaton Manufacturing Co.
Stearns Magnetic, Inc.
Western Gear Corp.

DRIVES, SHAFT MOUNTED
Falk Corp.

DRIVES, VARIABLE SPEED
Allis Chalmers Mfg. Co.
General Machinery Div.
Allis Co., Louis
American Blower Corp.
(Div. American-Standard)
American Pulley Co.
Brad Foote Gear Works
Browning Mfg. Co.
Century Electric Co.
Chicago Pulley & Shafting Co.
Clark Equipment Co.
Transmission Div.
Cleveland Worm & Gear Co.
Cotta Transmission Co.
Dodge Mfg. Corp.
Dominion Engineering Co., Ltd.
Dynamatic Div.
Eaton Manufacturing Co.
Eaton Mfg. Co.
Foote Bros. Gear & Machine Corp.
Fourwheel Drive Auto Co.
Fuller Manufacturing Co.
Gates Rubber Co.
General Electric Co.
Apparatus Sales Div.
General Motors Corp.
Allison Div.
Graybar Elec. Co., Inc.
Hewitt-Robins, Inc.
International General Electric Co.
Jones Foundry & Machine Co., W. A.
Lewellen Mfg. Co.
Lima Electric Motor Co.
Link-Belt Co.
Lovejoy Flexible Coupling Co.
Northwestern Electric Co.
Oilgear Co.
Oliver Iron & Steel Corp.
Prime Mover Co.
Reliance Electric & Engineering Co.
Reeves Pulley Co.
Sheppard Co., Inc., R. H.
Sterling Electric Motors, Inc.
Transall, Inc.
U. S. Electrical Motors, Inc.
Webb Co., Jervis B.
Western Gear Corp.
Worthington Corp.

DRYERS—see below: also see Furnaces; Heaters; or Kilns

DRYERS, CENTRIFUGAL
Bird Machine Co.
Blaw-Knox Co.
Dorr-Oliver, Inc.
Heyl & Patterson, Inc.
Majac Inc.
McNally Pittsburg Mfg. Corp.
Tema, N. V.

DRYERS, ELECTRIC VIBRATING
Carrier Conveyor Corp.
Jeffrey Mfg. Co.
Link-Belt Co.
Peterson Filters & Engr. Co.
Syntron Co.

DUST COLLECTORS—also see Classifiers, Cyclone, Dry; Filters, Air
Aerofall Mills, Inc.
American Air Filter Co., Inc.
American Blower Corp.
(Div. American-Standard)
Barber-Greene Co.
Bartlett & Snow Co., C. O.
Buell Enninеering Co.
Columbian Steel Tank Co.
Convair Inc.
Daniels Co. Contractors, Inc.
Drilling Accessory & Mfg. Co., Inc.
Ducon, Inc.
Dustex Corp.
Failing Co., George E.
Fly Ash Arrestor Corp.
Hazemag-MBH
Heinken Inc., W. P.
Houston Tool Co., Inc.
Iowa Mfg. Co.
Johnson-March Corp.
Joy Mfg. Co.
Kennedy-Van Saun Mfg. & Eng. Corp.
Kirk & Blum Mfg. Co.
Koppers Co., Inc.
Koppers Co., Inc.
Metal Prod. Div.
MacLeod Co.
Mahon Co., R. C.
Majac Inc.
Markley Dust Control System, Inc.
McNally Pittsburg Mfg. Corp.
Mechanical Industries, Inc.
Metals Disintegrating Co., Inc.
Pulverizing Machinery Div.
Mine Safety Appliances Co.
Northern Blower Co.
Ogden Iron Works
Omega Machine Co.
Pangborn Corp.
Parsons Engineering Corp.
Research-Cottrell, Inc.
Schneible Co., Claude B.
Shaffer Tool Works
Simplicity System Co.
Sly Mfg. Co., W. W.
Standard Electrical Tool Co.
Thompson-Starrett Co., Inc.
Roberts & Shaefer Co. Div.
Turner & Haws Engineering Co.
Universal Engineering Corp.
Western Precipitation Corp.
Westinghouse Air Brake Co.
Cleveland Rock Drill Plant, Le Roi Div.
Wheelabrator Corp.
Williams Patent Crusher & Pulverizer

DUST SAMPLERS
Houston Tool Co., Inc.
McNally Pittsburg Mfg. Corp.
Mechanical Industries, Inc.
Mine Safety Appliances Co.
Stapler Co.
Air Sampler Div.
Willson Products Div.
Ray-O-Vac Co.

ELECTRICAL BRUSHES
Calebaugh Self Lubricating Carbon Co.
Carbon Engineering Corp.
Carbone Corp.
General Electric Co.
Apparatus Sales Div.
General Electric Co.
Ind. Haulage Div.—Loco. & Car Equip. Divs.
Helwig Co.
Keystone Carbon Co.
Ohio Carbon Co.
Pure Carbon Co.
Southern Carbon Brush Co.
Speer Carbon Co.
Stackpole Carbon Co.
Superior Carbon Products, Inc.
Union Carbide & Carbon Corp.
National Carbon Co. Div.
United States Graphite Co. Div.
Wickes Corp.
Westinghouse Electric Corp.

ELECTRICAL CABLE
Alphaduct Wire & Cable Co.
Aluminum Co. of America
Anaconda Wire & Cable Co.
Ansonia Electrical Div.
Noma Electric Corp.
California Conduit & Cable Co.
Chester Cable Corp.
Circle F Mfg. Co.
Collyer Insulated Wire Co.
Colorado Fuel & Iron Co.
John A. Roebling's Sons Co. Div.
Copperweld Steel Co.
Crescent Insulated Wire & Cable Co.
Essex Wire Corp.
Paranite Wire & Cable Div.
Ettco Wire & Cable Corp.
Federal Telephone & Radio Div.
International Telephone and Telegraph Corp.
Flocker & Co., John
General Cable Corp.
General Electric Co.
Construction Materials Div.
General Electric Co.
Ind. Haulage Div.—Loco. & Car Equip. Divs.
Graybar Elec. Co., Inc.
Hales Co., W. M.
Hatheway & Co.
International General Electric Co.
Kaiser Aluminum & Chemical Sales, Inc.
Kerite Co.
National Electric Products Corp.
National Mine Service Co.
Okonite Co.
Hazard Insulated Wire Works Div.
Phelps Dodge Copper Products Corp.
Rockbestos Products Corp.
Rome Cable Corp.
Simplex Wire & Cable Co.
Triangle Conduit & Cable Co.
Tennessee Coal & Iron Div.
U. S. Steel Corp.
U. S. Steel Corp.
Columbia-Geneva Steel Div.
Walker Brothers
Western Insulated Wire Co.

ELECTRICAL CABLE ACCESSORIES
Aluminum Co. of America
American Hoist & Derrick Co.
American Mine Door Co.
Burndy Engrg. Co., Inc.
Deltron Electric Products, Inc.
Dicke Tool Co.
Electrical Engineers Equipment Co.
G. & W. Electric Specialty Co.
General Electric Co.
Ind. Haulage Div.—Loco. & Car Equip. Divs.
Graybar Elec. Co. Inc.
International General Electric Co.
Joy Mfg. Co.
Kellems Co.
Malleable Iron Fittings Co.
Memco Engineering & Mfg. Co.
National Electric Products Corp.
Okonite Co.
Hazard Insulated Wire Works Div.
O. Z. Electrical Mfg. Co.
Powercraft Corp.
Pyle-National Co.
Thomas & Betts Co.
Tennessee Coal & Iron Div.
U. S. Steel Corp.
Utilities Service Co.

ELECTRICAL CABLE ARMORED
Anaconda Wire & Cable Co.
Ansonia Wire & Cable Co.
Ansonia Electric Div.
Noma Electric Corp.
Chester Cable Corp.
Essex Wire Corp.
Paranite Wire & Cable Div.
Ettco Wire & Cable Corp.
Federal Telephone & Radio Div.
International Telephone and Telegraph Corp.
Flocker & Co., John
General Cable Corp.
General Electric Co.
Construction Materials Div.
Graybar Elec. Co., Inc.
International General Electric Co.
Kaiser Aluminum & Chemical Sales, Inc.
Kerite Co.
National Electric Products Corp.
Okonite Co.
Hazard Insulated Wire Works Div.
Phelps Dodge Copper Products Corp.
Rockbestos Products Corp.
Simplex Wire & Cable Co.
Triangle Conduit & Cable Co.
Tennessee Coal & Iron Div.
U. S. Steel Corp.
U. S. Steel Corp.
Columbia-Geneva Steel Div.
Walker Brothers

ELECTRICAL CABLE NON-METALLIC SHEATHED
Anaconda Wire & Cable Co.
Ansonia Wire & Cable Co.
Chester Cable Corp.
Collyer Insulated Wire Co.
Essex Wire Corp.
Paranite Wire & Cable Div.
Ettco Wire & Cable Corp.
Federal Telephone & Radio Div.
International Telephone and Telegraph Corp.
Flocker & Co., John
General Cable Corp.
General Electric Co.
Construction Materials Div.
General Electric Co.
Ind. Haulage Div.—Loco. & Car Equip. Divs.
Graybar Elec. Co., Inc.
International General Electric Co.
National Electric Products Corp.
Okonite Co.
Hazard Insulated Wire Works Div.
Phelps Dodge Copper Products Corp.
Rockbestos Products Corp.
Rome Cable Corp.
Simplex Wire & Cable Co.
Triangle Conduit & Cable Co.
Tennessee Coal & Iron Div.
U. S. Steel Corp.
U. S. Steel Corp.
Columbia-Geneva Steel Div.
Walker Brothers

ELECTRICAL CABLE SPLICERS
American Mine Door Co.
Burndy Engrg. Co., Inc.
Deltron Electric Products, Inc.
Elreco Corp.
Ensign Electric & Mfg. Co.
Flocker & Co John
Flood City Brass & Elec. Co.
Graybar Elec. Co., Inc.
Hales Co., W. M.
Joy Mfg. Co.
Irvington Varnish & Insulator Div.
Minnesota Mining & Mfg. Co.
Ohio Brass Co.
West Virginia Armature Co.

ELECTRICAL CONDUIT & FITTINGS —also see Pipe or Tubing
Aluminum Co. of America
Burndy Engrg. Co., Inc.
California Conduit & Cable Co.
Chester Cable Corp.
Crouse Hinds Co.
Electrical Fittings Corp.
Ettco Wire & Cable Corp.
Flexaust Co.
Gateway Center
General Electric Co.
Construction Materials Div.
General Electric Co.
Ind. Haulage Div.—Loco. & Car Equip. Divs.
Graybar Elec. Co., Inc.
Green Inc., R. H.
Ideal Industries, Inc.
International General Electric Co.
Johns-Manville
Killark Electric Mfg. Co.
National Electric Prod. Corp.
O. Z. Electrical Mfg. Co.
Pittsburgh Reflector Co.
Pyle-National Co.
Rattan Mfg. Co.
Rome Cable Corp.
Thomas & Betts Co.
V. V. Fittings Co.
Walker Brothers
Wiremold Co.
Youngstown Sheet & Tube Co.

ELECTRICAL CONVERTERS, SYNCHRONOUS
American Machine & Foundry Co.
Leland Electric Co., Div.
Elliott Co.
General Electric Co.
Apparatus Sales Div.
General Electric Co.
Ind. Haulage Div.—Loco. & Car Equip. Divs.
General Nuclear Corp.
Graybar Elec. Co., Inc.
International General Electric Co.
Kato Engineering Co.
Marathon Electric Mfg. Corp.
Northwestern Electric Co.
Robbins & Myers, Inc.

ELECTRICAL INSULATION
Boston Woven Hose & Rubber Co.
Chester Cable Corp.
Continental-Diamond Fibre Div.
Budd Inc.
Dow Corning Corp.
General Electric Co.
Ind. Haulage Div.—Loco. & Car Equip. Divs.
Goodrich Industrial Products Co., B. F.

Goodyear Tire & Rubber Co.
Graybar Elec. Co., Inc.
International General Electric Co.
Irvington Varnish & Insulator Div.
Minnesota Mining & Mfg. Co.
Johns-Manville
National Electric Coil Co.
National Vulcanized Fibre Co.
Okonite Co.
Plymouth Rubber Co.
Sauereisen Cement Co.
Saylor Electric Products Corp.
Synthane Corp.
Taylor Fibre Co.

ELECTRIC GENERATORS

Allis Chalmers Mfg. Co.
General Machinery Div.
Baldwin-Lima-Hamilton Corp.
American Machine & Foundry Co.
Beech Aircraft Corp.
Century Electric Co.
Columbia Electric Mfg. Co.
Continental Electric Co.
Diesel Energy Corp.
Electric Machinery Mfg. Co.
Electric Specialty Co.
Elliott Co.
Elliott Co.
Ridgway Div.
Fairbanks-Morse & Co.
General Electric Co.
Apparatus Sales Div.
Graybar Elec. Co., Inc.
Great Lakes Electric Mfg. Co.
Harnischfeger Corp.
P & H Diesel Div.
Hertner Electric Co.
Homelite Corp.
Ideal Electric & Mfg. Co.
Imperial Electric Co.
International General Electric Co.
Kato Engineering Co.
Klockner-Humboldt-Deutz Ag.
Kurz & Root Co.
Leach Corp.
Leland Electric Div.
American Machine & Foundry Co.
Le Roi Div.
Westinghouse Air Brake Co.
Louis Allis Co.
Marathon Electric Mfg. Corp.
Marble Card Electric Corp.
Master Electric Co.
Northwestern Electric Co.
Onan & Sons, Inc., D. W.
Ready Power Co.
Robbins & Myers, Inc.
Southern Oxygen Co.
Troy Ennine & Machine Co.
U. S. Motors Corp.
Universal Motor Co.
Waukesha Motor Co.
Westinghouse Electric Corp.

ELECTRIC MOTORS

Allis Chalmers Mfg. Co.
General Machinery Div.
American Machine & Foundry Co.
Armor Electric Mfg. Co.
Century Electric Co.
Chicago Pulley & Shafting Co.
Christian Engineers, J. D.
Cleveland Electric Motor Co.
Columbia Electric Mfg. Co.
Continental Electric Co.
DeWalt, Inc.
Dumore Co.
Electric Machinery Mfg. Co.
Electric Specialty Co.
Elliott Co.
Elliott Co.
Ridgway Div.
Fairbanks-Morse & Co.
General Electric Co.
Apparatus Sales Div.
General Electric Co.
Ind. Haulage Div.—Loco. & Car Equip. Divs.
Graybar Elec. Co., Inc.
Great Lakes Electric Mfg. Co.
Harnischfeger Corp.
P & H Diesel Div.
Ideal Electric & Mfg. Co.
Imperial Electric Co.
International General Electric Co.
Kurz & Root Co.
Leland Electric Div.
American Machine & Foundry Co.
Lima Electric Motor Co.
Lincoln Electric Co.
Louis Allis Co.
Marathon Electric Mfg. Corp.
Marble Card Electric Corp.
Master Electric Co.
Northwestern Electric Co.
Peerless Electric Co.
Reliance Electric & Engineering Co.
Robbins & Myers, Inc.
Smith Co., A. O.
Sterling Electric Motors, Inc.
Thor Power Tool Co.
U. S. Electrical Motors, Inc.
Wagner Electric Corp.
Western Gear Corp.
Westinghouse Electric Corp.
Worthington Corp.

ELECTRIC MOTORS, PROTECTED

Allis Chalmers Mfg. Co.
General Machinery Div.
American Machine & Foundry Co.
Armor Electric Mfg. Co.
Century Electric Co.
Continental Electric Co.
DeWalt, Inc.
Electric Machinery Mfg. Co.
Electric Specialty Co.
Elliott Co.
Fairbanks-Morse & Co.
General Electric Co.
Apparatus Sales Div.
General Electric Co.
Ind. Haulage Div.—Loco. & Car Equip. Divs.
Graybar Elec. Co., Inc.
Harnischfeger Corp.
P & H Diesel Div.
Howell Electric Motors Co.
Imperial Electric Co.
International General Electric Co.
Kurz & Root Co.
Leland Electric Div.
American Machine & Foundry Co.
Lima Electric Motor Co.
Lincoln Electric Co.
Louis Allis Co.
Marathon Electric Mfg. Corp.
Marble Card Electric Corp.
Master Electric Co.
Northwestern Electric Co.
Peerless Electric Co.
Reliance Electric & Engineering Co.
Robbins & Myers, Inc.
Smith Co., A. O.
Sterling Electric Motors, Inc.
U. S. Electrical Motors, Inc.
Wagner Electric Corp.
Western Gear Corp.
Westinghouse Electric Corp.

ELECTRIC MOTOR CONTROLLERS —also see Controls

Allen-Bradley Co.
Allis Chalmers Mfg. Co.
General Machinery Div.
Armor Electric Mfg. Co.
Arrow Hart & Hegeman Electric Co.
B-I-F Industries
Builders-Providence Div.
Clark Controller Co.
Cutler-Hammer, Inc.
Electric Controller & Mfg. Co. Div. Square D. Co.
Electric Machinery Mfg. Co.
Ensign Electric & Mfg. Co.
Euclid Electric & Mfg. Co.
Federal Pacific Electric Co.
General Electric Co.
Apparatus Sales Div.
General Electric Co.
Ind. Haulage Div.—Loco. & Car Equip. Divs.
Graybar Elec. Co., Inc.
Guyan Machy. Co.
Harnischfeger Corp.
P & H Diesel Div.
Ideal Electric & Mfg. Co.
International General Electric Co.
Ironton Engine Co.
Minneapolis-Honeywell Regulator Co.
Ward Leonard Electric Co.
Westinghouse Electric Corp.

ELECTRIC SWITCHGEAR & SWITCHES—also see Controls, Electrical; Meters, Electrical; Rectifiers; Transformers; or Voltage Regulators

Allis Chalmers Mfg. Co.
General Machinery Div.
Anderson Mfg. Co., Albert & J. M.
Arrow Hart & Hegeman Electric Co.
Automatic Switch Co.
Braun Corp.
BullDog Electric Products Co.
Circle F Mfg. Co.
Cutler-Hammer, Inc.
Delta-Star Electric Division
H. K. Porter Co., Inc.
Dooley Brothers
Durakool, Inc.
Electric Controller & Mfg. Co. Div. Square D. Co.
Electrical Engineers Equipment Co.
Elgin National Watch Co.
Federal Electric Co.
Pacific Electric Switchgear Div.
Federal Pacific Electric Co.
G. & W. Electric Specialty Co.
General Electric Co.
Ind. Haulage Div.—Loco. & Car Equip. Divs.
General Electric Co.
Trumbull Electric Dept.
General Electric Co.
Apparatus Sales Div.
General Equipment & Mfg. Co.
General Switch Corp.
Graybar Elec. Co., Inc.
Guyan Machy. Co.
Heinemann Electric Co.
International General Electric Co.
International General Electric Co.
I-T-E Circuit Breaker Co.
Kolton Electric Mfg. Co.
Line Material Co.
Memco Engineering & Mfg. Co.
Micro Switch Div.
Minneapolis-Honeywell Regulator Co.
Parker Electrical Mfg. Co.
Pittsburgh Electrical & Machine Works
Post-Glover Electric Co.
Powercraft Corp.
Pyle-National Co.
Royal Electric Mfg. Co.
Square D Co.
Superior Carbon Products, Inc.
Torsion Balance Co.
V. V. Fittings Co.
Wadsworth Electric Mfg. Co.
Wagner Electric Corp.
Westinghouse Air Brake Co.
Westinghouse Electric Corp.
Worthington Corp.

ELECTRIC UNIT SUBSTATIONS—also see Transformers

Allis Chalmers Mfg. Co.
General Machinery Div.
American Rubber Mfg. Co.
Boston Woven Hose & Rubber Co.
BullDog Electric Products Co.
Federal Pacific Electric Co.
Federal Electric Co.
Pacific Electric Switchgear Div.
General Electric Co.
Ind. Haulage Div.—Loco. & Car Equip. Divs.
General Electric Co.
Apparatus Sales Div.
Graybar Elec. Co., Inc.
I-T-E Circuit Breaker Co.
International General Electric Co.
Kolton Electric Mfg. Co.
Memco Engineering & Mfg. Co.
Sorgel Electric Co.
Wagner Electric Corp.
Westinghouse Electric Corp.

ENGINES—see below, also see Turbines

ENGINES, DIESEL

Alco Products, Inc.
Allis-Chalmers Mfg. Co.
Buda Div.
Allis Chalmers Mfg. Co.
Construction Machy. Div.
Allis Chalmers Mfg Co.
General Machinery Div.
Atlas Copco Pacific Inc.
Baldwin-Lima-Hamilton Corp.
Case Co., J. I.
Industrial Div.
Caterpillar Tractor Co.
Chicago Pneumatic Tool Co.
Compton, Inc.
Continental Motors Co.
Cooper-Bessemer Corp.
Cummins Engine Company, Inc.
Detroit Diesel Engine Div.
General Motors Corp.
Diesel Energy Corp.
Dominion Engineering Co., Ltd.
Fairbanks-Morse & Co.
General Motors Corp.
Electro-Motive Div.
Hallett Diesel Engine Div.
American M. A. R. C., Inc.
Harnischfeger Corp.
P & H Diesel Div.
Hercules Motors Corp.
Ingersoll-Rand Co.
International Harvester Export Co.
Klockner-Humboldt-Deutz Ag.
Lister-Blackstone, Inc.
Murphy Diesel Co.
Nordberg Mfg. Co.
Oliver Corp.
Onan & Sons, Inc., D. W.
Page Engineering Co.
Prescott Co.—Sterling Engine Co.
Sheppard Co., Inc., R. H.
Waukesha Motor Co.
White Diesel Engine Div.
White Motor Co.
Witte Engine Works
Oil Well Supply Div.
U. S. Steel Corp.
Worthington Corp.

ENGINES, GAS & GASOLINE

Allis-Chalmers Mfg. Co.
Buda Div.
Allis Chalmers Mfg. Co.
Construction Machy. Div.
Allis Chalmers Mfg. Co.
General Machinery Div.
Briggs & Stratton Corp.
Case Co., J. I.
Industrial Div.
Caterpillar Tractor Co.
Chicago Pneumatic Tool Co.
Chrysler Industrial Engine Div.
Clark Brothers Co., Div.
Dresser Operations, Inc.
Climax Engine & Pump Mfg. Co.
Continental Motors Co.
Cooper-Bessemer Corp.
Fairbanks-Morse & Co.
Ford Motor Co.
Gladden Products Corp.
Hercules Motors Corp.
International Harvester Export Co.
Le Roi Div.
Westinghouse Air Brake Co.
Oliver Corp.
Onan & Sons, Inc., D. W.
Nordberg Mfg. Co.
Prescott Co.—Sterling Engine Co.
Waukesha Motor Co.
Westinghouse Air Brake Co.
White Diesel Engine Div.
White Motor Co.
Willys Motors, Inc.
Wisconsin Motor Corp.
Witte Engine Works
Oil Well Supply Div.
U. S. Steel Corp.

ENGINES, STEAM

American Hoist & Derrick Co.
Clark Brothers Co. Div.
Dresser Operations, Inc.
Condenser Service & Engineering Co.
Holmes & Bros., Inc., Robert
Nordberg Mfg. Co.
Skinner Engine Co.
Troy Engine & Machine Co.

EXHAUST SCRUBBERS, ENGINE

Eimco Corp.
Fluor Products Co.
National Mine Service Co.
Ruth Co.
Sanford-Day Iron Works, Inc.

EXPLORATION SERVICE—see specific type below, also see Drilling Contractors; Mapping; or Consultants; and Searchlight Section

EXPLORATION SERVICE, AERIAL

Aero Service Corp.
Abrams Aerial Survey Corp.
African Surveys (Pty.), Ltd.
Ammann Photogrammetric Engineers, Inc., Jack
Canadian Aero Service, Ltd.
Cummings Jr., & Associates, Robt. A.
Engineers Syndicate, Ltd.
Fairchild Aerial Surveys, Inc.
Hycon Aerial Surveys, Inc.
Laylander, Philip A.
Levantementos Aerofotogrammetricos, S. A.
Longyear Co., E. J.
Manu-Mine Research & Devel. Co.
Minerals Exploration & Research Corp.
Nuclear Exploration Co.
Photographic Survey Corp., Ltd.
Radiac Co., Inc.
Seismograph Service Corp.
Societe Aerienne de Recherches Miniares
Spartan Air Services, Ltd.
Universal Atomics Corp.

EXPLORATION SERVICE, GEOLOGICAL

Aero Service Corp.
African Surveys (Pty.), Ltd.
Canadian Aero Service, Ltd.
Consolidated Diamond Drill Corp., Ltd.
Engineers Syndicate, Ltd.
Fisher Research Laboratory, Inc.
Laylander, Philip A.
Levantementos Aerofotogrammetricos, S. A.
Rua da Alfrandega
Lundberg Explorations, Ltd.
McPhar Geophysics, Ltd.
Minerals Engineering Co.
Minerals Exploration & Research Corp.
Nuclear Exploration Co.
Societe Aerienne de Recherches Minieres
Resources Development Corp.
Snyder Mine & Chemical Lab.

EXPLORATION SERVICE, GEOPHYSICAL

Aero Service Corp.
Abrams Aerial Survey Corp.
African Surveys (Pty.), Ltd.
Canadian Aero Service, Ltd.
Borden Engineering Co.
Engineers Syndicate, Ltd.
Fairchild Aerial Surveys, Inc.
Fisher Research Laboratory Inc.
Geophysical Service Inc.
Levantementos Aerofotogrammetricos, S. A.
Longyear Co., E. J.
Lundberg Explorations, Ltd.

Minerals Engineering Co.
Minerals Exploration & Research Corp.
McPhar Geophysics, Ltd.
Nuclear Exploration Co.
Nuclear Instrument & Chemical Corp.
Photographic Survey Corp., Ltd.
Radiac Co., Inc.
Seismograph Service Corp.
Societe Aerienne de Recherches Minieres
Spartan Air Services, Ltd.
Texas Instruments, Inc.
Universal Atomics Corp.

EXPLOSIVES—see Blasting Compounds

FANS & BLOWERS
Aerofall Mills, Inc.
American Air Filter Co., Inc.
American Blower Corp. (Div. American-Standard)
American Machine & Metals, Inc. De Bothezat Fan Div.
Baldor Electric Co.
Buffalo Forge Co.
Campbell Co., E. K.
Carey Mfg. Co., Philip
Chelsea Fan & Blower Co.
Clarage Fan Co.
Coppus Engineering Co.
DeLaval Steam Turbine Co.
Diehl Mfg. Co.
Dresser Industries, Inc.
Drullard Co., Howard
Fly Ash Arrestor Corp.
Graybar Elec. Co., Inc.
Guyan Machy. Co.
Hannon & Sons, F. R.
Hartzell Propeller Fan Co.
Ilg Electric Ventilating Co.
Ingersoll-Rand Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Kennedy-Van Saun Mfg. & Eng. Corp.
Mahr Mfg. Co.
Martin Fan & Blower Co.
McNally Pittsburg Mfg. Corp.
Mine Safety Appliances Co.
Moore Co.
New Jersey Meter Co.
Northern Blower Co.
Peerless Electric Co.
Robbins & Myers, Inc.
Sanford-Day Iron Works Brown-Fayro Div.
South Bend Air Products, Inc.
Spencer Turbine Co.
Standard Elec. Mfg. Co., Inc.
Trufio Fan Co.
Western Gear Corp.
Westinghouse Electric Corp. Sturtevant Div.
Westinghouse Electric Corp.
Williams & Green
Wing Mfg. Co., L. J.

FASTENERS—SCREWS, BOLTS, NUTS, WASHERS, ETC.—also see Rock & Roof Bolts
Ackerman-Johnson Co.
Aluminum Co. of America
Bethlehem Pacific Coast Steel Corp.
Bristol Co.
Chase Brass & Copper Co.
Chicago Expansion Bolt Co.
Dominion Steel & Coal Corp., Ltd.
Elastic Stop Nut Corp. of America
Fenwick Mfg., Co.
Hales Co., W. M.
Lamson & Sessions Co.
Lewis Bolt & Nut Co.
Line Material Co.
Maryland Bolt & Nut Co.
National Production Co.
Pittsburgh Screw & Bolt Co.
Rockford Bolt & Steel Co.
Security Locknut Corp.
St. Louis Screw & Bolt Co.
Sheffield Steel Div. Armco Steel Corp.
Star Expansion
Steward & Romaine Mfg. Co.
Strong, Carlisle & Hammond Co.
Torrington Co.
Union Carbide & Carbon Corp. Haynes Stellite Co. Div.
United States Steel Supply Co.
Wood Steel Co., Alan

FEEDERS—see specific item below, also see Conveyors

FEEDERS, APRON—see Feeders, Pan

FEEDERS, BELT
Acme Road Machinery Co.
Atlas Conveyor Co.
Barber-Greene Co.
Bartlett & Snow Co., C. O.
B-I-F Industries Builders-Providence Div.
Bodinson Manufacturing Co., Inc.
Bonded Scale & Machine Co.
Clain Belt Co.
Christian Engineers, J. D.
Continental Gin Co. Industrial Div.
Conveyor Co.
Davis Foundry & Machine Works
Denver Equipment Co.
Fairmont Machinery Co.
Gallagher Co.
Gruendler Crusher & Pulverizer Co.
Hack Engineering Co.
Hardinge Co., Inc.
Hewitt-Robins, Inc.
Hirsch Bros. Machy. Co.
Holmes & Bros., Inc., Robert
Iowa Mfg. Co.
Jeffrey Mfg. Co.
Johnson Co., C. S.
Joy Mfg. Co.
Kanawha Mfg. Co.
Kennedy-Van Saun Mfg. & Eng. Corp.
Kremser & Sons, Inc., Frank A.
Link-Belt Co.
Lippmann Engineering Works
Marsh Engineering Co., E. F.
McNally Pittsburg Mfg. Corp.
Morse Bros. Machinery Co.
National Iron Co.
Ogden Iron Works
Omega Machine Co.
Pioneer Engineering Works, Inc.
Smith Engineering Works
Standard Steel Corp.
Stephens-Adamson Mfg. Co.
Straub Mfg. Co.
Transall, Inc.
Union Iron Works
Universal Dredge Mfg. Co.
Universal Road Machinery Co.
Washington Machinery Co.
Webster Mfg., Inc.

FEEDERS, CHAIN
Acme Road Machinery Co.
Bartlett & Snow Co., C. O.
Bodinson Manufacturing Co., Inc.
Chain Belt Co.
Christian Engineers, J. D.
Continental Gin Co. Industrial Div.
Conveyor Co.
Fairmont Machinery Co.
Gruendler Crusher & Pulverizer Co.
Hirsch Bros. Machy. Co.
Holmes & Bros., Inc., Robert
Jeffrey Mfg. Co.
Kremser & Sons, Inc., Frank A.
Link-Belt Co.
National Iron Co.
Prins & Associates K.
Ross Screen & Feeder Co.
Smith Engineering Works
Stephens-Adamson Mfg. Co.
Transall, Inc.
Union Chain & Mfg. Co.
Washington Machinery Co.
Webster Mfg., Inc.

FEEDERS, CONSTANT WEIGHT
Arnold & Weigel Div. Toledo Engineering Co., Inc.
B-I-F Industries Builders-Providence Div.
Conveyor Co.
Hardinge Co., Inc.
Hewitt-Robins, Inc.
Industrial Physics & Electronics Co.
Jeffrey Mfg. Co.
Merrick Scale Mfg Co.
Omega Machine Co.
Permutit Co.
Pulva Corp.
Schaffer Poidometer Co.
Syntron Co.

FEEDERS, PAN
Acme Road Machinery Co.
Baldwin-Lima-Hamilton Corp.
Baldwin-Lima-Hamilton Corp. Construction Equipment Div.
Barber-Greene Co.
Bartlett & Snow Co., C. O.
Birdsboro Steel Foundry & Machine Co.
Bodinson Manufacturing Co., Inc.
Bonded Scale & Machine Co.
Carrier Conveyor Corp.
Chain Belt Co.
Christian Engineers, J. D.
Conveyor Co.
Continental Gin Co. Industrial Div.
Denver Equipment Co.
Diamond Iron Works Div. Goodman Mfg. Co.
Fairmont Machinery Co.
Gruendler Crusher & Pulverizer Co.
Hack Engineering Co.
Hewitt-Robins, Inc.
Hirsch Bros. Machy. Co.
Holmes & Bros., Inc., Robert
Iowa Mfg. Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Kanawha Mfg. Co.
Kennedy-Van Saun Mfg. & Eng. Corp.
Kremser & Sons, Inc., Frank A.
Link-Belt Co.
Lippmann Engineering Works
Marsh Engineering Co., E. F.
McNally Pittsburg Mfg. Corp.
National Iron Co.
Ogden Iron Works
Pettibone Mulliken Corp.
Pioneer Engineering Works, Inc.
Prins & Associates K.
Rogers Iron Works Co.
Simplicity Engineering Co.
Simplicity System Co.
Smith Engineering Works
Standard Steel Corp.
Stephens-Adamson Mfg. Co.
Transall, Inc.
Traylor Engineering & Mfg. Co.
Thompson-Starrett Co., Inc. Roberts & Schaefer Co. Div.
Union Iron Works
Universal Dredge Mfg. Co.
Universal Engineering Corp.
Washington Machinery Co.
Webster Mfg., Inc.
Williams & Green

FEEDERS, REAGENT—see Reagent Feeders

FEEDERS, RECIPROCATING
Acme Road Machinery Co.
Atlas Conveyor Co.
Baldwin-Lima-Hamilton Corp.
Baldwin-Lima-Hamilton Corp. Construction Equipment Div.
Barber-Greene Co.
Bartlett & Snow Co., C. O.
Beaumont Birch Co.
Bodinson Manufacturing Co., Inc.
Bonded Scale & Machine Co.
Carrier Conveyor Corp.
Chain Belt Co.
Continental Gin Co. Industrial Div.
Conveyor Co.
Denver Equipment Co.
Fairmont Machinery Co.
Gruendler Crusher & Pulverizer Co.
Hack Engineering Co.
Hewitt-Robins, Inc.
Holmes & Bros., Inc., Robert
Iowa Mfg. Co.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Kremser & Sons, Inc., Frank A.
Link-Belt Co.
Lippmann Engineering Works
Marsh Engineering Co., E. F.
McLanahan & Stone Corp.
McNally Pittsburg Mfg. Corp.
National Iron Co.
Pioneer Engineering Works, Inc.
Prins & Associates, K.
Smith Engineering Works
Stephens-Adamson Mfg. Co.
Straub Mfg. Co.
Syntron Co.
Thompson-Starrett Co., Inc. Roberts & Schaefer Co. Div.
Transall, Inc.
Traylor Engineering & Mfg. Co.
Universal Dredge Mfg. Co.
Washington Machinery Co.
Webster Mfg., Inc.
Wilmot Engineering Co.

FEEDERS, ROTARY VANE
Fuller Co.

FEEDERS, SCREW—see Conveyors, Screw

FEEDERS, TABLE
Allis Chalmers Mfg. Co. General Machinery Div.
Bartlett & Snow Co., C. O.
Blaw-Knox Co.
Continental Gin Co. Industrial Div.
Conveyor Co.
Deister Concentrator Co.
Denver Equipment Co.
Hardinge Co., Inc.
Jeffrey Mfg. Co.
Link-Belt Co.
Nordberg Mfg. Co.
Pulva Corp.
Transall, Inc.
Traylor Engineering & Mfg. Co.
Williams & Green

FEEDERS, VIBRATING
Barber-Greene Co.
Beaumont Birch Co.
Carrier Conveyor Corp.
Cleveland Vibrator Co.
Erinz Mfg. Co.
Hewitt-Robins, Inc.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Kennedy-Van Saun Mfg. & Eng. Corp.
Link-Belt Co.
Omega Machine Co.
Pittsburgh Plate Glass Co. Columbia-Southern Div.
Richardson Scale Co.
Ridge Equipment Co.
Simplicity Engineering Co.
Smith Engineering Works
Stephens-Adamson Mfg. Co.
Syntron Co.
Williams & Green

FILTER BAGS
Albany Felt Co.
American Air Filter Co., Inc.
Bemis Bro. Bag Co.
Brosites Products Corp.
Daniels Co. Contractors, Inc.
Ducon, Inc.
Eimco Corp.
Filter Fabric Inc.
Filtration Engineers Inc.
Houston Tool Co., Inc.
Indiana Commercial Filters Corp.
Koppers Co., Inc. Metal Prod. Div.
Mechanical Industries, Inc.
National Filter Media Corp.
Pendleton Woolen Mills
Peterson Filters & Engr. Co.
Plummer Mfg. Co., W. A.
Portland Woolen Mills, Inc. Industrial Fabrics Div.
Sly Mfg. Co., W. W.
Stanley Co., Inc., William W.
Winslow Engineering Co.

FILTER CLOTH
Albany Felt Co.
American Air Filter Co., Inc.
Brosites Products Corp.
Buffalo Wire Works Co.
Cleveland Wire Cloth & Mfg. Co.
Colorado Fuel & Iron Corp. Wickwire Spencer Steel Div.
Condenser Service & Engineering Co.
Eimco Corp.
Filter Fabric Inc.
Filtration Engineers, Inc.
House & Sons, Inc., Chas. W.
Koppers Co., Inc. Metal Prod. Div.
Mechanical Industries, Inc.
Mt. Vernon-Woodberry Mills, Inc.
National Filter Media Corp.
Newark Wire Cloth Co.
Pendleton Woolen Mills
Peterson Filters & Engr. Co.
Plummer Mfg. Co., W. A.
Portland Woolen Mills, Inc. Industrial Fabrics Div.
Riegel Textile Corp.
Shriver & Co., T.
Sly Mfg. Co., W. W.
Turner Halsey Co.
Tyler Co., W. S.
Wellington Sears Co.

FILTER MEDIA (other than bags & cloth)
American Air Filter Co., Inc.
Brosites Products Corp.
Eimco Corp.
Filter Fabric Inc.
Filtration Engineers, Inc.
Food Machinery & Chemical Corp. Westvaco Mineral Products Div. Westvaco Chlor-Alkali Div.
Indiana Commercial Filters Corp.
Johns-Manville
Koppers Co., Inc. Metal Prod. Div.
Mechanical Industries, Inc.
Mine Safety Appliances Co.
Mt. Vernon-Woodberry Mills, Inc.
National Filter Media Corp.
Newark Wire Cloth Co.
Norton Co.
Peterson Filters & Engr. Co.
Portland Woolen Mills, Inc.
Shriver & Co., T.
Stanley Co., Inc., William W.
United States Filter Co.

FILTERS, AIR GAS & DUST
American Air Filter Co., Inc.
Brosites Products Corp.
Convair, Inc.
Coppus Engineering Co.
Ducon, Inc.
Drullard Co., Howard
Engelhard, Inc., Charles
Goodyear Tire & Rubber Co.
Hisey-Wolf Machine Co.
Houston Tool Co., Inc.
Indiana Commercial Filters Corp.
Johnson Corp.
Koppers Co., Inc.
Lincoln Engineering Co.
Mechanical Industries, Inc.
Mine Safety Appliances Co.
New Jersey Meter Co.
Stanley Co., Inc., William W.
Staplex Co. Air Sampler Div.
Thor Power Tool Co.
Turner & Haws Engineering Co.
Victor Equipment Co.
Westinghouse Air Brake Co. Ind. Products Div.
Westinghouse Electric Corp. Sturtevant Div.

Wilkerson Corp.
Winslow Engineering Co.
J. A. Zurn Mfg. Co.

FILTERS, CONCENTRATE
Bird Machine Co.
Booth Co.
Brosites Products Corp.
Dagley Mfg. Co.
Denver Equipment Co.
Dorr-Oliver, Inc.
Dravo Corp.
Eimco Corp.
Filtration Engineers, Inc.
Galigher Co.
Komline-Sanderson Engineering Corp.
Minerals Engineering Co.
Morse Bros. Machinery Co.
Peterson Filters & Engr. Co.
Shriver & Co., T.
J. A. Zurn Mfg. Co.

FILTERS, ENGINE OIL
Purolator Products, Inc.

FILTERS, WATER & LIQUID
American Water Softener Co.
Bethlehem Pacific Coast Steel Corp.
B-I-F Industries
Builders-Providence Div.
Bird Machine Co.
Brosites Products Corp.
Carter Co., Ralph B.
Condenser Service & Engineering Co.
Dorr-Oliver, Inc.
Duriron Co., Inc.
Eimco Corp.
Hardinge Co., Inc.
Indiana Commercial Filters Corp.
Infilco, Inc.
Marvel Engineering Co.
Permutit Co.
Schroeder Brothers
United States Filter Co.
Winslow Engineering Co.
J. A. Zurn Mfg. Co.

FIRE FIGHTING EQUIPMENT & SUPPLIES
Construction Machy. Co.
Curtiss-Wright Corp.
Electronics Div.
Elkhart Brass Mfg. Co.
Falcon Alarm Co., Inc.
Fourwheel Drive Auto Co.
Fyr-Fyter Co.
Graybar Elec. Co., Inc.
Grinnell Co., Inc.
Hewitt-Robins, Inc.
Kidde & Co., Inc., Walter
Mine Safety Appliances Co.
Porto Pump Inc.
Snyder & Son, Inc., M. L.
Southern Oxygen Co.
Spartan Air Services, Ltd.
Stop Fire, Inc.
Willys Motors, Inc.

FIRST AID EQUIPMENT & SUPPLIES
Bullard Co., E. D.
Mine Safety Appliances Co.
National Mine Service Co.
Onox, Inc.
Southern Oxygen Co.

FLOOD LIGHTS, ELECTRIC
American Optical Co.
Crouse Hinds Co.
General Electric Co.
Apparatus Sales Div.
Giant Mfg. Co.
Graybar Elec. Co., Inc.
Homelite Corp.
International General Electric Co.
Kerrigan Iron Works, Inc.
Mine Safety Appliances Co.
Multi Electrical Mfg. Co.
Phoenix Metal Products Co.
Pittsburgh Reflector Co.
Pyle-National Co.
Smoot-Holman Co.
Snyder & Son, Inc., M. L.
Steber Mfg. Co.
Westinghouse Electric Corp.

FLOTATION MACHINES
Athey Products Corp.
Booth Co.
Dagley Mfg. Co.
Davis Foundry & Machine Works
Denver Equipment Co.
Fahrenwald Co., A. W.
Galigher Co.
Morse Bros. Machinery Co.
Union Iron Works
Western Machinery Co.
Wilmot Engineering Co.

FLOTATION REAGENTS
American Cyanamid Co.
Mineral Dressing Dept.
Armour & Co.
Barrett Div.
Allied Chemical & Dye Corp.
Canadian Industries Ltd.
Ciba Co.
Commercial Solvent Corp.
Cummings Jr., & Associates, Robt. A.
Dewey & Almy Chemical Co.
DuPont de Nemours & Co., E. I.
Emery Industries, Inc.
Dow Chemical Co.
General Mills, Inc.
Hercules Powder Co.
Industrial Oil Products Corp.
Marathon Corp.
Minerec Corp.
Newport Industries, Inc.
Oronite Chemical Co.
Pacific Lumber Co.
Philadelphia Quartz Co.
Rohm & Haas Co.
Sharples Chemicals Div.
Pennsylvania Salt Mfg. Co.
Shell Oil Co.
Sonneborn Sons, Inc., L.
Stein, Hall & Co., Inc.
Thompson-Starrett Co., Inc.
Roberts & Schaefer Co. Div.
Union Carbide & Carbon Chemical Co.
West End Chemical Co.
Wust Virginia Pulp & Paper Co.

FLOTATION REAGENT FEEDERS — see Reagent Feeders

FOOD (PACKAGED KITS)
Bolton Farm Packing Co., Inc.

FORGES, OIL BURNING
Acme Fishing Tool Co. Div.
Stardrill-Keystone Co.
Gardner Denver Co.
Hauck Manufacturing Co.
Mahr Mfg. Co.
Spang & Co.
Stardrill-Keystone Co.

FORGINGS, DROP, ET AL
American Brake Shoe Co.
American Forge Co.
American Steel Foundries
Bethlehem Steel Co., Inc.
Bethlehem Pacific Coast Steel Corp.
Bohn Aluminum & Brass Corp.
Cameron Iron Works
Columbus Forge & Iron Co.
Chase Brass & Copper Co.
Commercial Shearing & Stamping, Inc.
Conley Frog & Switch Co.
Crucible Steel Co. of America
Electric Materials Co.
Endicott Forging & Mfg. Co.
General Motors Corp.
New Departure Div.
Giant Grip Mfg. Co.
Globe Forge, Inc.
Holmes & Bros., Inc., Robert
Interstate Drop Forge Co.
Ladish Co.
Launhlin Co., Div.
American Hoist & Derrick Co.
Le Bus Rotary Tool Works
Midvale — Heppenstall
Moore Drop Forging Co.
Mueller Brass Co.
Ohio Forge & Machine Corp.
Oliver Iron & Steel Corp.
Philadelphia Steel & Iron Co.
Pittsburgh Knife & Forge Co.
Rockwell Spring & Axle Co.
Timken-Detroit Axle Div.
Stardrill-Keystone Co.
Tube Turns Div.
National Cylinder Gas Co.
Transue & Williams Steel Forging Corp.
Upson-Walton Co.
Webb Co., Jervis B.
Willys Motors, Inc.

FREEZEPROOFING MATERIALS
Fuel Process Co.
International Salt Co.
Master Builders Co.
Morton Salt Co.
Wyandotte Chemicals Corp
Michigan Alkali Div.

FURNACE LININGS, WALLS & ARCHES — also see Refractories
Babcock & Wilcox Co.
Bellevue Industrial Furnace Co.
Bigelow-Liptak Corp.
Carborundum Co.
Refractories Div.
Dixon Crucible Co., Joseph
Englehard, Inc., Charles
Food Machinery & Chemical Corp.
Westvaco Mineral Products Div.
Westvaco Chlor Alkali Div.
Ironton Fire Brick Co.
Mexico Refractories Co.
Norton Co.
Quigley Co., Inc.
Reinties Co., George P.
Salem-Brosius, Inc.
Superior Carbon Products, Inc.

FURNACES—see specific item below; also see Heaters; or Kilns

FURNACES, ELECTRIC
American Bridge Div.
U. S. Steel Corp.
Bellevue Industrial Furnace Co.
Blue M Electric Co.
Eisler Engineering Co.
Elektrokemisk A. S.
General Electric Co.
Apparatus Sales Div.
Graybar Elec. Co., Inc.
Harper Electric Furnace Corp.
Hevi-Duty Electric Co.
International General Electric Co.
Koppers Co., Inc.
Kuhlman Electric Co.
Mahr Mfg. Co.
Lectromelt Furnace Co. Div.
McGraw Electric Co.
Pittsburgh Lectromelt Furnace Corp.
Salem-Brosius, Inc.
United American Metals Corp.
U. S. Steel Corp.
American Bridge Div.
Westinghouse Electric Corp.
Whiting Corp.

FURNACES, MUFFLE
Bellevue Industrial Furnace Co.
Blue M Electric Co.
General Engineerinn Co., Ltd.
Harper Electric Furnace Corp.
Hevi-Duty Electric Co.
Hoskins Mfg. Co.
Mahr Mfg. Co.
Michigan-Standard Alloy Casting Co.
Nichols Engineering & Research Corp.
Skookum Co.

FURNACES, ROASTING
Bethlehem Foundry & Machine Co.
Bigelow-Liptak Corp.
Colorado Iron Works
Dorr-Oliver, Inc.
Gould Co., Gordon I.
Mace Co.
Nichols Engineering & Research Corp.
Pacific Foundry Co., Ltd.
Stearns Roger Mfg. Co.
U. S. Smelting Furnace Co.

FURNACES, SMELTING
Bellevue Industrial Furnace Co.
Elektrokemisk A. S.
Lectromelt Furnace Co. Div.
McGraw Electric Co.
McFarlane-Egners Machinery Co.
Pittsburgh Lectromelt Furnace Corp.
Salem-Brosius, Inc.
Treadwell Co., M. H.
United American Metals Corp.
Whiting Corp.

FURNACES, TEMPERING & FORGING
Bethlehem Pacific Coast Steel Corp.
Bellevue Industrial Furnace Co.
Blue M Electric Co.
General Engineering Co., Ltd.
Mahr Mfg. Co.
Salem-Brosius, Inc.

GAGES, PRESSURE & VACUUM — see Meters, Fluid

GALVANOMETERS — see Meters, Electricity

GAS (& HUMIDITY) DETECTORS & INDICATORS—also see Meters
Beckman Instruments Inc.
Process Instruments Dept.
Brabender Corp.
Consolidated Electrodynamics Corp.
Engelhard, Inc., Charles
Fisher & Porter Co.
General Electric Co.
Apparatus Sales Div.
International General Electric Co.
Mine Safety Appliances Co.
National Mine Service Co.
Taller & Cooper, Inc.

GAS GENERATORS
Bellevue Industrial Furnace Co.
Carlile & Associates, J. C.
General Electric Co.
Apparatus Sales Div.
International General Electric Co.
Joy Mfg. Co.
Southern Oxygen Co.
Union Carbide & Carbon Corp.
Linde Air Products Co. Div.

GASKETS
American Rubber Mfg. Co.
Belmont Packing & Rubber Co.
Chicago Rawhide Mfg. Co.
Continental-Diamond Fibre Div.
Budd Inc.
Garlock Packing Co.
Gilmer Co., L. H.
Goodall Rubber Co.
Greene Tweed Co.
Hewitt-Robins, Inc.
Johns-Manville
Keasbey & Mattison Co.
McCord Corp.
Metallo Gasket Co.
National Vulcanized Fibre Co.
New York Belting & Packing Co.
Porter Co., Inc., H. K.
Quaker Pioneer Rubber Div.
Raybestos-Manhattan, Inc.
Manhattan Rubber Div.
Rhoads & Son, J. E.
Snyder & Son, Inc., M. L.

GEAR MOTORS—also see Drives
Falk Corp.
Reliance Electric & Engrg. Co.
Westinghouse Electric Co.

GEARS & PINIONS, METAL
American Brake Shoe Co.
American Steel Div.
Bethlehem Pacific Coast Steel Corp.
Birdsboro Steel Foundry & Machine
Black's Machine Shop
Blaw-Knox Co.
Bodinson Manufacturing Co., Inc.
Brad Foote Gear Works
Brad Foote Gear Works
Pittsburgh Gear Co. Div.
Brown, Inc., David
Chicago Gear Mfg. Co.
Chicago Pulley & Shafting Co.
Christian Engineers, J. D.
Clark Equipment Co.
Transmission Div.
Clarkson Manufacturing Co.
Cullman Wheel Co.
Davis Foundry & Machine Works
Dominion Engineering Co., Ltd.
Eberhardt Denver Co.
Subsidiary of Morse Chain Co.
Falk Corp.
Farrel-Birmingham Co., Inc.
Farrell-Cheek Steel Co.
Foote Bros. Gear & Machine Corp.
Gear Specialties, Inc.
Hewitt-Robins, Inc.
Hirsch Bros. Machy. Co.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Mahr Mfg. Co.
Massachusetts Gear & Tool Co.
Meckum Engineering, Inc.
McNally Pittsburg Mfg. Corp.
Michigan Tool Co.
Cone Drive Gear Div.
National Iron Co.
Ogden Iron Works
Ohio Forge & Machine Corp.
Ohio Gear Co.
Penn Machine Co.
Perkins Machine & Gear Co.
Pittsburgh Gear Co.
Rockwell Spring & Axle Co.
Timken-Detroit Axle Div.
Philadelphia Gear Works
Savage Co., W. J.
Stahl Gear & Machine Co.
Stearns Roger Mfg. Co.
Stroh Process Steel Co.
Tool Steel Gear & Pinion Co.
Transall, Inc.
Union Iron Works
Washington Machinery Co.
Western Gear Corp.
Westinghouse Electric Corp.
Wilmot Engineering Co.
Vulcan Iron Works

GEARS & PINIONS, NON-METALLIC
Blaw-Knox Co.
Brad Foote Gear Works
Brad Foote Gear Works
Pittsburgh Gear Co. Div.
Brown, Inc., David
Chicago Gear Mfg. Co.
Chicago Pulley & Shafting Co.
Christian Engineers, J. D.
Continental-Diamond Fibre Div.
Budd Inc.
Eberhardt Denver Co.
Subsidiary of Morse Chain Co.
Farrel-Birmingham Co., Inc.
Gear Specialties, Inc.
Hewitt-Robins, Inc.
Hirsch Bros. Machy. Co.
Jeb Instruments Co.
Massachusetts Gear & Tool Co.
National Vulcanized Fibre Co.
Ohio Gear Co.
Penn Machine Co.
Perkins Machine & Gear Co.
Stahl Gear & Machine Co.
Union Iron Works
Western Gear Corp.
Westinghouse Electric Corp.

GEIGER COUNTERS — see Radiation Detectors

GEOPHYSICAL INSTRUMENTS—also see Radiation Detectors or Ultraviolet Lights
Associated Research, Inc.

Atomic Research Corp.
Beckman Instruments Inc.
Berkeley Div.
Conveyor Co.
Engineers Syndicate, Ltd.
Geophysical Instrument & Supply Co.
Goldak Co., Inc.
Gurley, W. & L. E.
Houston Technical Laboratories
Hycon Aerial Surveys, Inc.
McPhar Manufacturing, Ltd.
Nuclear Instrument & Chemical Corp.
Precision Radiation Instruments, Inc.
Radiac Co., Inc.
Seismograph Service Corp.
Sherwin Instrument Co.
Southwestern Industrial Electronics Co.
Special Instruments Laboratory, Inc.
Sprengnether Instrument Co., Inc., W. F.
Suverkrop Instruments
Snyder Mine & Chemical Lab.
Texas Instruments, Inc.
Universal Atomics Corp.
Westinghouse Air Brake Co.

GRADER BLADES — see Bulldozer & Grader Blades

GRADERS, ROAD, TOWED & SELF-PROPELLED

Allis-Chalmers Mfg. Co.
Construction Machy. Div.
Allis-Chalmers Mfg. Co.
General Machinery Div.
Austin-Western Works
Construction Equipment Div.
Baldwin-Lima-Hamilton Corp.
Blaw-Knox Co.
Caterpillar Tractor Co.
Galion Iron Works
Le Tourneau-Westinghouse Co.
Pettibone Mulliken Corp.
Westinghouse Air Brake Co.

GRATINGS, FLOOR

Kerlow Steel Flooring Co.
Smith Co., A. O.
Drava Corp.
Borden Metal Products Co.
Bates Co., Walter
Blaw-Knox Co.
Hendrick Mfg. Co.
Irving Subway Grating Co., Inc.
Kerrigan Iron Works, Inc.
Klemp Metal Grating Corp.
Ryerson & Son, Inc., Joseph T.
United States Steel Supply Co.
Zurn Mfg. Co., J. A.

GRINDERS & BUFFERS, ELECTRIC

Baldor Electric Co.
Bitco, Inc.
Blount Co., J. G.
Chicago Pneumatic Tool Co.
Cincinnati Electrical Tool Co.
DeWalt, Inc.
Dumore Co.
Graybar Elec. Co., Inc.
Hisey-Wolf Machine Co.
Ingersoll-Rand Co.
Kennametal Inc.
Milwaukee Electric Tool Corp.
New Era Engineering Co.
Queen City Machine Tool Co.
South Bend Lathe Works
Standard Electrical Tool Co.
Stanley Electric Tools Div.
Stanley Works
Thor Power Tool Co.
Williams & Green

GRINDERS & BUFFERS, PNEUMATIC

Atlas Copco Pacific, Inc.
Chicago Pneumatic Tool Co.
Ingersoll-Rand Co.
Thor Power Tool Co.

GRINDING (& CUTTING) WHEELS

Atlas Copco Pacific, Inc.
Bay State Abrasive Products Co.
Braun Corp.
Chicago Wheel & Mfg. Co.
Clipper Mfg. Co.
DeWalt, Inc.
Kennametal Inc.
Macklin Co.
Marathon Coal Bit Co.
Precision Grinding Wheel Co., Inc.
Raybestos-Manhattan, Inc.
Manhattan Rubber Div.
Simonds Worden White Co.
Sterling Grinding Wheel Co.
Thor Power Tool Co.
United States Steel Supply Co.
Vitrified Wheel Co.
Waltham Grinding Wheel Co.

GRIZZLIES

Allison Steel Mfg. Co.
American Steel Foundries
Baldwin-Lima-Hamilton Corp.
Colorado Fuel & Iron Corp.
Colorado Fuel & Iron Corp.
Wickwire Spencer Steel Div.
Davis Foundry & Machine Works
Denver Equipment Co.
Gruendler Crusher & Pulverizer Co.
Hewitt-Robins, Inc.
Holmes & Bros., Inc., Robert
Iowa Mfg. Co.
Jeffrey Mfg. Co.
Kennedy-Van Saun Mfg. & Eng. Corp.
Maddox Foundry & Machine Works, Inc.
McLanahan & Stone Corp.
McNally Pittsburg Mfg. Corp.
Nordberg Mfg. Co.
Ogden Iron Works
Phillips Corp.
Prins & Associates, K.
Rogers Iron Works Co.
Ross Screen & Feeder
Simplicity Engineering Co.
Smith Engineering Works
Syntron Co.
P & H Diesel Div.
Traylor Engineering & Mfg. Co.
Tyler Co., W. S.
Union Iron Works
Universal Engineering Corp.
Yuba Manufacturing Co.

GROUTING PUMPS — see Pumps (& Blowers), Concrete

HARDFACING ALLOYS & RODS — also see Metalizing or Welding

Air Reduction Co., Inc.
All-State Welding Alloys Co., Inc.
Alloy Rods Co.
American Brake Shoe Co.
American Brake Shoe Co.
American Steel Div.
American Chain & Cable Co., Inc.
Page Steel & Wire Div.
Ampco Metal, Inc.
Coast Metals, Inc.
Crucible Steel Co. of America
Eutectic Welding Alloys Corp.
Firth Sterling, Inc.
Harnischfeger Corp.
P & H Diesel Div.
Taylor-Wharton Co. Div.
Harsco Corp.
Industrial Overlay Metals, Inc.
National Cylinder Gas Co.
Rankin Manufacturing Co.
Resisto-loy Co., Inc.
Shwayder Chemical Metallurgy Corp.
Sight Feed Generator Co.
Southern Oxygen Co.
Stoody Co.
Stulz-Sickles Co.
Thomas Foundries, Inc.
Union Carbide & Carbon Corp.
Haynes Stellite Co. Div.
United States Steel Supply Co.
Victor Equipment Co.

HEAT EXCHANGERS—see Boilers or Coolers

HEATERS, SPACE, WATER & DRYING—also see Furnaces; Kilns

Acme Electric Heating Co.
American Blower Corp.
(Div. American-Standard)
Campbell Co. E. K.
Carrier Corp.
Drava Corp.
General Electric Co.
Apparatus Sales Div.
Guyan Machy. Co.
Hartzell Propeller Fan Co.
Hauck Manufacturing Co.
Ilg Electric Ventilating Co.
Indiana Foundry Co.
International General Electric Co.
Johnson Corp.
McCord Corp.
Penberthy Injector Co.
Pratt-Daniel Corp.
Thermobloc Div.
Rust Furnace Co.
Quick Charge, Inc.
Vulcan Electric Co.
Wing Mfg. Co., L. J.

HEAVY MEDIA SEPARATORS — see Separators, Heavy Media

HOISTS — see specific type below; also see Winches

American Chain & Cable Co., Inc.
Wright Hoist Div.
American Engineering Co.
Atlas Copco Pacific, Inc.
Bodinson Manufacturing Co., Inc.
Chicago Pneumatic Tool Co.
Christian Engineers, J. D.
Clyde Iron Works, Inc.
Connellsville Mfg. & Mine Supply Co.
Construction Machy. Co.
Curtis Manufacturing Co.
Denver Equipment Co.
Detroit Hoist & Machine Co.
Coffing Hoist Div.
Duff-Norton Co.
Electro Lift, Inc.
Essick Manufacturing Co.
Forker Corp.
Galion Allsteel Body Co.
Gardner Denver Co.
Gar Wood Industries, Inc.
Hales Co., W. M.
Harnischfeger Corp.
P & H Diesel Div.
Harrington Co.
Heil Co.
Hercules Steel Products Corp.
Hewitt-Robins, Inc.
Heyl & Patterson, Inc.
Hirsch Bros. Machy. Co.
Ingersoll-Rand Co.
Joy Mfg. Co.
Joyce-Cridland Co.
Ledeen Mfg. Co.
Lidgerwood Industries, Inc.
Lug-All Co.
Manning, Maxwell & Moore, Inc.
Shaw Box Crane & Hoist Div.
O.K. Machinery Div.
John C. Motter Printing Press Co.
National Iron Co.
Chester Hoist Div.
National Screw Mfg. Co.
Novo Pump & Engine Co.
Ohio Hoist & Mfg. Co., Inc.
Pacific Coast Engineering Co.
Reading Crane & Hoist Corp.
Robbins & Myers, Inc.
Round & Son, Inc., David
Ryerson & Son, Inc., Joseph T.
Sanford-Day Iron Works, Inc.
Sanford-Day Iron Works
Brown-Fayro Div.
Sauerman Bros., Inc.
Shepard Niles Crane & Hoist Corp.
Stephens-Adamson Mfg. Co.
Stimmel Winch Co., Inc.
Superior-Lidgerwood-Mundy Corp.
Thor Power Tool Co.
Vulcan Iron Works
Vulcan Iron Works Co., (Denver)
Western Gear Corp.
Willamette Iron & Steel Co.
Yale & Towne Mfg. Co.
Yale Materials Handling Div.
Yuba Manufacturing Co.

HOISTS, CRANE & DERRICK TYPES

American Hoist & Derrick Co.
Blaw-Knox Co.
Cleveland Crane & Engrg. Co.
Clyde Iron Works, Inc.
Dominion Engineering Co., Ltd.
Harnischfeger Corp.
P & H Diesel Div.
Harrington Co.
Hewitt-Robins, Inc.
Heyl & Patterson, Inc.
Hyster Co.
Koehring Co.
Lakeside Bridge & Steel Co.
Lidgerwood Industries, Inc.
Manning, Maxwell & Moore, Inc.
Shaw Box Crane & Hoist Div.
Ohio Hoist & Mfg. Co., Inc.
Pacific Coast Engineering Co.
Reading Crane & Hoist Corp.
Robbins & Myers, Inc.
Shepard Niles Crane & Hoist Corp.
Stimmel Winch Co., Inc.
Superior-Lidgerwood-Mundy Corp.
Western Gear Corp.
Yale & Towne Mfg. Co.
Yale Materials Handling Div.
Yuba Manufacturing Co.

HOISTS, HAND CHAIN

American Chain & Cable Co., Inc.
Wright Hoist Div.
Cleveland Crane & Engrg. Co.
Conco Engineering Works
Coffing Hoist Div.
Duff-Norton Co.
Forker Corp.
Graybar Elec. Co., Inc.
Hales Co., W. M.
Harnischfeger Corp.
P & H Diesel Div.
Harrington Co.
Lug-All Co.
Manning, Maxwell & Moore, Inc.
Shaw Box Crane & Hoist Div.
Chester Hoist Div.
National Screw Mfg. Co.
Ohio Hoist & Mfg. Co., Inc.
Reading Crane & Hoist Corp.
Robbins & Myers, Inc.
Round & Son, Inc., David
Ryerson & Son, Inc., Joseph T.
Stephens-Adamson Mfg. Co.
Yale & Towne Mfg. Co.
Yale Materials Handling Div.

HOISTS, MINE SHAFT — also see Sheaves; Skips & Cages

Aros Electric, Inc.
Clyde Iron Works, Inc.
Connellsville Mfg. & Mine Supply
Gardner Denver Co.
Hirsch Bros. Machy. Co.
Ingersoll-Rand Co.
Joy Mfg. Co.
Lake Shore, Inc.
Lake Shore Engineering Div.
Link-Belt Co.
Manning, Maxwell & Moore, Inc.
Shaw Box Crane & Hoist Div.
Mayo Tunnel & Mine Equipment Co.
Morse Bros. Machinery Co.
National Iron Co.
Nordberg Mfg. Co.
Ohio Hoist & Mfg. Co., Inc.
Reading Crane & Hoist Corp.
Rogers Iron Works Co.
Shepard Niles Crane & Hoist Corp.
Stearns Roger Mfg. Co.
Superior-Lidgerwood-Mundy Corp.
Vulcan Iron Works
Vulcan Iron Works Co., (Denver)
Washington Iron Works
Western Gear Corp.
Yale & Towne Mfg. Co.
Yale Materials Handling Div.

HOISTS, MONORAIL

American Chain & Cable Co., Inc.
Wright Hoist Div.
American Engineering Co.
Chester Hoist Div.
National Screw Mfg. Co.
Cleveland Crane & Engrg. Co.
Cleveland Electric Motor Co.
Coffing Hoist Div.
Duff-Norton Co.
Colorado Fuel & Iron Corp.
Wickwire Spencer Steel Div.
Conco Engineering Works
Detroit Hoist & Machine Co.
Electro Lift, Inc.
Forker Corp.
Harnischfeger Corp.
P & H Diesel Div.
Harrington Co.
Houdaille Industries, Inc.
Manzel Div.
Louden Machinery Co.
Manning, Maxwell & Moore, Inc.
Shaw Box Crane & Hoist Div.
Ohio Hoist & Mfg. Co., Inc.
Reading Crane & Hoist Corp.
Robbins & Myers, Inc.
Ryerson & Son, Inc., Joseph T.
Shepard Niles Crane & Hoist Corp.
Yale & Towne Mfg. Co.
Yale Materials Handling Div.

HOISTS, PORTABLE & MOVABLE

American Chain & Cable Co., Inc.
Wright Hoist Div.
Chester Hoist Div.
National Screw Mfg. Co.
Chicago Pneumatic Tool Co.
Coffing Hoist Div.
Duff-Norton Co.
Conco Engineering Works
Electro Lift, Inc.
Flood City Brass & Elec. Co.
Gardner Denver Co.
Graybar Elec. Co., Inc.
Griphoist, Inc.
Harnischfeger Corp.
P & H Diesel Div.
Ingersoll-Rand Co.
Joy Mfg. Co.
Lidgerwood Industries, Inc.
Lug-All Co.
Manning, Maxwell & Moore, Inc.
Shaw Box Crane & Hoist Div.
Ohio Hoist & Mfg. Co., Inc.
Princeton Griphoist, Inc.
Reading Crane & Hoist Corp.
Robbins & Myers, Inc.
Round & Son, Inc., David
Ryerson & Son, Inc., Joseph T.
Sanford-Day Iron Works, Inc.
Shepard Niles Crane & Hoist Corp.
Stimmel Winch Co., Inc.
Yale & Towne Mfg. Co.
Yale Materials Handling Div.

HOISTS, STATIONARY

American Engineering Co.
American Hoist & Derrick Co.
Chester Hoist Div.
National Screw Mfg. Co.
Clyde Iron Works, Inc.
Coffing Hoist Div.
Duff-Norton Co.
Electro Lift, Inc.
Harnischfeger Corp.
P & H Diesel Div.
Holmes & Bros., Inc., Robert
Ingersoll-Rand Co.
Joy Mfg. Co.
Lake Shore, Inc.
Lake Shore Engineering Div.
Lidgerwood Industries, Inc.
Manning, Maxwell & Moore, Inc.
Shaw Box Crane & Hoist Div.
Mayo Tunnel & Mine Equipment Co.
National Iron Co.
Novo Pump & Engine Co.

Ohio Hoist & Mfg. Co., Inc.
Reading Crane & Hoist Corp.
Robbins & Myers, Inc.
Sanford-Day Iron Works, Inc.
Shepard Niles Crane & Hoist Corp.
Stearns Roger Mfg. Co.
Stimmel Winch Co., Inc.
Superior-Lidgerwood-Mundy Corp.
Thompson-Starrett Co., Inc.
Roberts & Schaefer Co. Div.
Washington Iron Works
Yale & Towne Mfg. Co.
Yale Materials Handling Div.

HOIST CONTROLLERS — also see Controls

Allen-Bradley Co.
Clark Controller Co.
Electric Controller & Mfg. Co. Div.
Square D. Co.
General Electric Co.
Apparatus Sales Div.
General Electric Co.
Ind. Haulage Div.-Loco. & Car Equip. Divs.
Harnischfeger Corp.
P & H Diesel Div.
International General Electric Co.
Ohio Hoist & Mfg. Co., Inc.

HOSE, AIR, STEAM, WATER, et al.

Aeroquip Corp.
American Ventilating Hose Co.
Atlas Copco Pacific, Inc.
Carlyle Rubber Co.
Continental Rubber Works
Chicago Pneumatic Tool Co.
Cincinnati Rubber Mfg. Co.
Drullard Co., Howard
Eimco Corp.
Gates Rubber Co.
Gilmer Co., L. H.
Goodall Rubber Co.
Goodrich Co., B. F.
Truck & Bus Tire Dept.
Goodrich Industrial Products Co., B. F.
Goodyear Tire & Rubber Co.
Goodyear Tire & Rubber Co.
Industrial Products
Hamilton Rubber Mfg. Corp.
Hewitt-Robins, Inc.
Howells Mining Drill Co.
Joy Mfg. Co.
Lincoln Engineering Co.
Mayhew Machine & Supply Co.
National Motor Bearings
Arrowhead Rubber Co. Div.
New York Belting & Packing Co.
Porter Co., Inc. H. K.
Quaker Pioneer Rubber Div.
Porter Co., Inc., H. K.
Quaker Rubber Co. Div.
Quick Charge, Inc.
Raybestos-Manhattan, Inc.
Manhattan Rubber Div.
Republic Rubber Div.
Lee Rubber & Tire Corp.
Snyder & Son, Inc., M. L.
Stratoflex, Inc.
Thermoid Co.
Industrial Div.
Thor Power Tool Co.
United States Rubber Co.
Hose Div.
United States Steel Supply Co.
Weatherhead Co.
Fort Wayne Div.

HOSE FITTINGS — CLAMPS, COUPLINGS, SWIVEL JOINTS, ETC.

Aeroquip Corp.
Boston Woven Hose & Rubber Co.
Carlyle Rubber Co.
Central Mine Supply Co.
Chicago Pneumatic Tool Co.
Chiksan Co.
Cincinnati Rubber Mfg. Co.
Continental Rubber Works
Crane Co.
Drullard Co., Howard
Eastman Mfg. Co.
Eastman-Pacific Co.
Elkhart Brass Mfg. Co.
Goodall Rubber Co.
Goodyear Tire & Rubber Co.
Hales Co. W. M.
Hewitt-Robins, Inc.
Hose Accessories Co.
Howells Mining Drill Co.
Hunt & Son, Inc., C. B.
Joy Mfg. Co.
Lincoln Engineering Co.
Lunkenheimer Co.
Meckum Engineering, Inc.
Punch-Lok Co.
Quick Charge, Inc.
Raybestos-Manhattan, Inc.
Manhattan Rubber Div.
Snap-Tite, Inc.
Snyder & Son, Inc., M. L.
Stratoflex, Inc.
Thermoid Co.
Industrial Div.
Thor Power Tool Co.
Titeflex, Inc.
Victor Equipment Co.
Weatherhead Co.
Fort Wayne Div.
Westinghouse Air Brake Co.
Ind. Products Div.

HUBS, AUTO. WHEEL, SELECTIVE DRIVE

Warn Mfg. Co.

HYDRAULIC CYLINDERS—see Cylinders, Air & Hydraulic

HYDRAULIC MONITOR — see Monitors

HYDRAULIC MOTORS

American Brake Shoe Co.
American Engineering Co.
Blackhawk Mfg. Co.
Commercial Shearing & Stamping, Inc.
New York Air Brake Co.
Hydraulic Div.
Oilgear Co.
Oliver Iron & Steel Corp.
Schroeder Brothers
Vickers, Inc.

HYDRAULIC PUMPS — see Pumps, Hydraulic Fluid

HYDRAULIC RAMS—see Pumps, Hydraulic Ram

HYDROMETER—see Meters, Liquid

INSULATION, ELECTRICAL — see Electrical Insulation

INSULATION (THERMAL) CLOTH & PAPER

American Asbestos Textile Corp.
Carborundum Co.
Refractories Div.
Carey Mfg. Co., Philip
General Electric Co.
Ind. Haulage Div.-Loco. & Car Equip. Divs.
Harbison-Walker Refractories Co.
Johns-Manville
Keasbey & Mattison Co.
Owens-Corning Fiberglas Corp.
Plummer Mfg. Co., W. A.
Ruberoid Co.

INSULATION (THERMAL) COMPOUNDS—also see Refractories

Asbestos Fibre Spinning Co.
Asbestos Mfg. Co.
Carey Mfg. Co., Philip
Dow Corning Corp.
Eagle-Picher Co.
Goodyear Tire & Rubber Co.
Johns-Manville
Ruberoid Co.
Sauereisen Cement Co.
Trotter & Co., E. T.

INSULATION (THERMAL) BOARD & SHEET—also see Refractories

Asbestos Fibre Spinning Co.
Asbestos Mfg. Co.
Barrett Div.
Allied Chemical & Dye Corp.
Carey Mfg. Co., Philip
General Refractories, Co.
Goodyear Tire & Rubber Co.
Gustin-Bacon Mfg. Co.
Harbison-Walker Refractories Co.
Johns-Manville
Keasbey & Mattison Co.
Owens-Corning Fiberglas Corp.
Pittsburgh Plate Glass Co.
Columbia-Southern Div.
Ruberoid Co.

INSULATION (THERMAL) BULK — also see Refractories

Barrett Div.
Allied Chemical & Dye Corp.
Carey Mfg. Co., Philip
Carborundum Co.
Refractories Div.
Eagle-Picher Co.
Goodyear Tire & Rubber Co.
Gustin-Bacon Mfg. Co.
Harbison-Walker Refractories Co.
Mexico Refractories Co.
Quigley Co., Inc.

ION EXCHANGERS—also see Water Treatment

Allis Chalmers Mfg. Co.
General Machinery Div.
American Water Softener Co.
Connellsville Mfg. & Mine Supply
Dorr Oliver, Inc.
Epley Products, Inc.
Infilco, Inc.
Ionics, Inc.
Permutit Co.
Peterson Filters & Engrg. Co.
Van Waters & Rogers, Inc.

ION EXCHANGE RESINS

Chemical Processing Co.
National Aluminate Corp.
Permutit Co.
Rohm & Haas Co.

JACKS, LIFTING

Blackhawk Mfg. Co.
Dake Corp.
Duff Norton Co.
Foster Co., L. B.
Gibraltar Equipment & Mfg. Co.
Graybar Elec. Co., Inc.
Hales Co., W. M.
Illinois Iron & Bolt Co.
Joyce-Cridland Co.
National Mine Service Co.
Star Jack Co.
Stimmel Winch Co., Inc.
Swett Iron Works, A. L.
Templeton, Kenly & Co.
Whiting Corp.
Yuba Manufacturing Co.

JACKS, PULLING

Armstrong-Bray & Co.
Blackhawk Mfg. Co.
Crane Puller Co.
Dake Corp.
Duff Norton Co.
Gibraltar Equipment & Mfg. Co.
Graybar Elec. Co., Inc.
Illinois Iron & Bolt Co.
Joyce-Cridland Co.
Nolan Co.
Owatonna Tool Co.
Patton Mfg. Co., Inc.
Star Jack Co.
Templeton, Kenly & Co.

JIGS—see Separators, Jig

JOURNAL BOXES—see Bearing Hangers, Journal Boxes, etc.

KILNS & DRYERS — also see Dryers; Furnaces; or Heaters

Alco Products, Inc.
Allis Chalmers Mfr Co.
General Machinery Div.
Arnold & Weigel Div.
Toledo Engineering Co., Inc.
Barber-Greene Co.
Bartlett & Snow Co., C. O.
Bethlehem Foundry & Machine Co.
Blaw-Knox Co.
Blaw-Knox Co.
Buffovak Equip. Div.
Bodinson Manufacturing Co., Inc.
Booth Co.
Chattanooga Boiler & Tank Co.
Colorado Iron Works
Davis Foundry & Machine Works
Denver Equipment Co.
Dorr Oliver, Inc.
General American Transportation Corp.
General American Transportation Corp.
Louisville Dryer Div.
Gould Co., Gordon I.
Hardinge Co., Inc.
Harper Electric Furnace Corp.
Hazemag-MBH
Heineken, Inc., W. P.
Heyl & Patterson, Inc.
Holmes & Bros., Inc., Robert
Indiana Foundry Co.
Iowa Mfg. Co.
Kennedy-Van Saun Mfg. & Eng. Corp.
Link-Belt Co.
Maddox Foundry & Machine Works, Inc.
McNally Pittsburg Mfg. Corp.
Nordberg Mfg. Co.
Ogden Iron Works
Simplicity System Co.
Smidth & Co., F. L.
Standard Steel Corp.
Stearns Roger Mfg. Co.
Stroh Process Steel Co.
Thompson-Starrett Co. Inc.
Roberts & Schaefer Co. Div.
Traylor Engineering & Mfg. Co.
Union Iron Works
Vulcan Iron Works (Pa.)
Washington Machinery Co.
Western Precipitation Corp.

KILN (& INDUSTRIAL) GUNS

Industrial Sales Div.
Remington Arms Co., Inc.

LABORATORIES — ANALYZING ASSAYING & TESTING SERVICE—also see Searchlight Section

American Spectrographic Laboratories
Arizona Assay Office
Arizona Testing Laboratories
Beach & Co.
Booth Co.
California Testing Laboratories, Inc.
Chapman & Wood
Charlton Laboratories
Claiborne, Kilby V.
Commercial Testing & Engrg. Co.
Consolidated Electrodynamics Corp.
Critchett & Ferguson
Custom Assay Office
Deason & Nichols
Denver Equipment Co.
Dickinson Laboratories, Inc.
Dorr Oliver, Inc.
Eisenhauer Laboratories
El Paso Testing Laboratories
Goodall Brothers
Gulick-Henderson Laboratories, Inc.
Hanks, Inc., Abbot A.
Hawley & Hawley
Hill & Jude, Assayers
Jarrell-Ash Co.
Ledoux & Co.
Manu-Mine Research & Devel. Co.
Minerals Laboratory
New Mexico Minerals Laboratory
Nuclear Instrument & Chemical Corp.
Pitkin, Inc., Lucius
Root & Simpson Inc.
Sherwin Instrument Co.
Smith-Emery Co.
Stearns Magnetic, Inc.
Stowell & Co., W. H.
Snyder Mine & Chemical Lab.
Taller & Cooper Inc.
Tour & Co., Sam
Twining Laboratories
U. S. Testing Co.
Walker & Whyte, Inc.
Wood Assaying Co., Henry E.

LABORATORY EQUIPMENT & SUPPLIES

American Instrument Co., Inc.
Bausch & Lomb Optical Co.
Beckman Instruments, Inc.
Bethlehem Pacific Coast Steel Corp.
Bico, Inc.
Blue M Electric Co.
Booth Co.
Braun Corp.
Buffalo Hammer Mill Corp.
Cargille Laboratories, Inc., R. P.
Carpco Manufacturing, Inc.
Central Scientific Co.
Charcoal Corp. of America
Coors Porcelain Co.
Corning Glass Works
Denver Equipment Co.
Eberbach Corp.
Eimco Corp.
Electro Products Laboratories
Exide Industrial Div.
Electric Storage Battery Co.
Fahrenwald Co., A. W.
Fisher Scientific Co.
Gallgher Co.
General Chemical Div.
Allied Chemical & Dye Corp.
Baker & Adamson Products
Gilson Screen Co.
Holmes & Bros., Inc., Robert
International General Electric Co.
Jarrell-Ash Co.
La Roe Instruments, Inc.
Ledoux & Co.
Macbeth Daylighting Corp.
Mallinckrodt Chemical Works
McFarlane-Eggers Machinery Co.
Mead Mill Co.
Menlo Research Laboratory
Metals Disintegrating Co., Inc.
Pulverizing Machinery Div.
Mine & Smelter Supply Co.
Marcy Mill Div.
Morse Bros. Machinery Co.
Newage International Inc.
Newark Wire Cloth Co.
North American Phillips Co.
Patterson Foundry & Machine Co.
Pulva Corp.
Radiac Co., Inc.
Radiation Counter Laboratories
Realty & Industrial Corp.
Sturtevant Mill Co.
Tracerlab, Inc.
Tyler Co., W. S.
Universal Vibrating Screen Co.
Van Waters & Rogers, Inc.
Voland & Sons, Inc.
Western Machinery Co.
Wise Co., O. B.

LAMPS, HEAVY DUTY—also see Floodlights

Atlas Copco Pacific, Inc.
Graybar Elec. Co., Inc.
International General Electric Co.
Killark Electric Mfg. Co.
Pyle-National Co.
Ray-O-Vac Co.

LARRIES & WAGONS — see Mine Cars; Skips & Cages; or Truck (& Tractor) Trailers & Wagons

LININGS, ABRASION RESISTANT, METALLIC—see Hardfacing; Metallizing; or Steel, alloy

LININGS, ABRASION RESISTANT—NON-METALLIC—also see Coatings

Bigelow-Liptak Corp.

Boston Woven Hose & Rubber Co.
Carborundum Co.
Refractories Div.
Carey Mfg. Co., Philip
Corhart Refractories Co.
Galigher Co.
Gates Engrg. Co.
Gatke Corp.
Goodrich Industrial Products Co., B. F.
Goodyear Tire & Rubber Co.
Goodyear Tire & Rubber Co.
Industrial Products
Hardinge Co., Inc.
Linatex Corp. of America
Norton Co.
Patterson Foundry & Machine Co.
Raybestos-Manhattan Inc.
Manhattan Rubber Div.

LININGS, CORROSION RESISTANT

Bigelow-Liptak Corp.
Boston Woven Hose & Rubber Co.
Braun & Co., C. F.
Carborundum Co.
Refractories Div.
Carey Mfg. Co., Philip
Electric Steel Foundry Co.
Galigher Co.
Gates Engrg. Co.
Goodall Rubber Co.
Goodrich Industrial Products Co., B. F.
Goodyear Tire & Rubber Co.
Hardinge Co., Inc.
Hauser-Stander Tank Co.
Koppers Co., Inc.
Linatex Corp. of America
Patterson Foundry & Machine Co.
Permagile Corp. of America
Quigley Co., Inc.
Raybestos-Manhattan, Inc.
Manhattan Rubber Div.
Rem Cru Titanium, Inc.
Royston Laboratories

LININGS, CORROSION RESISTANT, METALLIC—also see Metallizing or Steel, alloy

LININGS, CORROSION RESISTANT, NON-METALLIC—also see Coatings

LIQUID METERS—see Meters, Fluid

LOADERS—see specific type below; also see Shovels, Power; Conveyors; or Slushers

Allis Chalmers Mfg. Co.
Construction Machy. Div.
Athey Products Corp.
Barber-Greene Co.
Eimco Corp.
Harnischfeger Corp.
P & H Diesel Div.
Heyl & Patterson, Inc.
Jaeger Machine Co.
Jov Mfg. Co.
Joyce-Cridland Co.
Kennedy-Van Saun Mfg. & Eng. Corp.
Lippmann Engineering Works
McKiernan-Terry Corp.
Myers-Whaley Co., Inc.
Ottumwa Box Car Loader Co.
Rogers Iron Works Co.
Sanford-Day Iron Works
Brown-Fayro Div.
Shaft & Development Machines Co.
Specialty Engineering Co.
Vulcan Iron Works Co. (Denver)

LOADERS, BOXCAR

Heyl & Patterson, Inc.
Hough Co., Frank G.
Jaeger Machine Co.
Kennedy-Van Saun Mfg. & Eng. Corp.
McNally Pittsburg Mfg. Corp.
Ottumwa Box Car Loader Co.
Silent Hoist & Crane Corp.
Specialty Engineering Co.
Stephens-Adamson Mfg. Co.
Western Gear Corp.

LOADERS, CHAIN, BELT AND/OR BUCKET ELEVATOR TYPE

Le Tourneau-Westinghouse Co.

LOADERS, FRONT-END SCOOP, CRAWLER

Allis Chalmers Mfg. Co.
Construction Machy. Div.
Allis Chalmers Mfg. Co.
General Machinery Div.
American Tractor Equipment Corp.
Ateco Div.
Balderson, Inc.
Caterpillar Tractor Co.
Dempster Brothers, Inc.
Drott Mfg. Co.
Eimco Corp.
Hough Co., Frank G.
International Harvester Export Co.
Jaeger Machine Co.
Oliver Corp.
Sanford-Day Iron Works, Inc.
Tractomotive Corp.

LOADERS, FRONT END SCOOP, WHEELED

Allis Chalmers Mfg. Co.
General Machinery Div.
Baker Raulang Co.
Clark Equipment Co.
Construction Machinery Div.
Dempster Brothers, Inc.
Drott Mfg. Co.
Gardner Denver Co.
Hough Co., Frank G.
International Harvester Export Co.
Napco Industries, Inc.
Oliver Corp.
Pettibone Mulliken Corp.
Schramm, Inc.
Sheppard Co., Inc. R. H.
Tractomotive Corp.
Westinghouse Air Brake Co.

LOADERS, GATHERING ARM

Clarkson Manufacturing Co.
Joy Mfg. Co.
Long Co.
Mavor & Coulson, Ltd.

LOADERS, OVERCAST, CRAWLER, RAIL & WHEELED

Caterpillar Tractor Co.
Eimco Corp.
Harnischfeger Corp.
P & H Diesel Div.
Ottumwa Box Car Loader Co.

LOCOMOTIVES, COMPRESSED AIR

Davenport Besler Corp.
Eimco Corp.
Hack Engineering Co.
Mavo Tunnel & Mine Equipment Co.
Universal Dredge Mfg. Co.

LOCOMOTIVES, ELECTRIC BATTERY & TROLLEY

Atlas Car & Mfg. Co.
Differential Steel Car Co.
General Electric Co.
Apparatus Sales Div.
General Electric Co.
Ind. Haulage Div.—Loco. & Car Equip. Divs.
Greensburg Machinery Co.
Mancha Storage Battery Locomotive Div.
Goodman Mfg. Co.
International General Electric Co.
Ironton Engine Co.
Jeffrey Mfg. Co.
Kersey Mfg. Co., Inc.
Thumes Mek. Vaerksted, A. S.
West Virginia Armature Co.

LOCOMOTIVES, GASOLINE, DIESEL & DIESEL-ELECTRIC

Alco Products, Inc.
Atlas Car & Mfg. Co.
Baldwin-Lima-Hamilton Corp.
Brookville Locomotive Works
Davenport Besler Corp.
Fairbanks-Morse & Co.
General Electric Co.
Apparatus Sales Div.
General Electric Co.
Ind. Haulage Div.—Loco. & Car Equip. Divs.
General Motors Corp.
Electro-Motive Div.
Hack Engineering Co.
International General Electric Co.
Klockner-Humboldt-Deutz Ag.
c/o Diesel Energy Corp.
Mancha Storage Battery Locomotive Div.
Goodman Mfg. Co.
Mavo Tunnel & Mine Equipment Co.
Pl-mouth Locomotive Works Div.
Fate-Root-Heath Co.
Ruth Co.
Thumes Mek. Vaerksted, A. S.
Universal Dredge Mfg. Co.
Vulcan Iron Works

LOCOMOTIVES, STEAM

Davenport Besler Corp.
Thumes Mek. Vaerksted, A. S.
Vulcan Iron Works

LOG WASHERS—see Scrubbers & Washers, Mineral

LUBRICANTS

ACF Industries, Inc.
Alpha Molykote Corp.
American Oil Co.
Ashland Oil & Refining Co.
Atlantic Refining Co.
Borne Scrymser Co.
Brooks Oil Co.
Cities Service Oil Co.
Climax Molybdenum Co.
Continental Oil Co.
D-A Lubricant Co., Inc.
Dixon Crucible Co., Joseph
Dow Corning Corp.
Drullard Co., Howard
Esso Standard Oil Co.
Fiske Bros. Refining Co.
Lubriplate Div.
Gulf Oil Corp.
Gulf Refining Co.
Houghton & Co., E. F.
Hulburt Oil & Grease Co.
Jesco Lubricants Co.
Jet-Lube, Inc.
Kevstone Lubricating Co.
Leschen Wire Rope Div.
H. K. Porter Co., Inc.
Lockrey Co.
Macmillan Petroleum Corp.
Mallinckrodt Chemical Works
New York & New Jersey Lubricant Co.
Ohio Grease Co.
Ohio Oil Co.
Phillips Petroleum Co.
Pure Oil Co.
Shell Oil Co.
Sinclair Refining Co.
Socony Mobil Oil Co.
Sonneborn Sons, Inc., L.
Southwestern Petroleum Co.
Standard Oil Co. of California
Western Div.
Standard Oil Co.—Indiana
Stewart-Warner Corp.
Alemite Div.
Sun Oil Co.
Swan-Finch Oil Corp.
Texas Co.
Tennessee Coal & Iron Div.
U. S. Steel Corp.
Tide Water Associated Oil Co.
Union Oil Co. of California
Utah Oil Refining Co.
Valvoline Oil Co. Div.
Ashland Oil & Refining Co.
Whitmore Mfg. Co.

LUBRICATING EQUIPMENT

Dravo Corp.
Farval Corp.
Frontier Industries, Inc.
Manzel Div.
Gray & Co., Inc.
Houdaille Industries, Inc.
Manzel Div.
Jesco Lubricants Co.
Jet-Lube, Inc.
Lincoln Engineering Co.
Lunkenheimer Co.
McCord Corp.
Nathan Mfg. Co.
Stewart-Warner Corp.
Alemite Div.
Trabon Engineering Corp.
Trico Fuse Mfg. Co.

MAGNETS—also see Pulleys, Magnetic or Separators, Magnetic

Allegheny Ludlum Steel Corp.
Carboloy Dept.
General Electric Co.
Carpco Manufacturing, Inc.
Crucible Steel Co. of America
Dings Magnetic Separator Co.
Electric Controller & Mfg. Co. Div.
Square D. Co.
Eriez Mfg. Co.
Homer Mfg. Co.
International General Electric Co.
Magnetic Engineering & Mfg. Co.
Ohio Electric Mfg. Co.
Schield Bantam Co.
Schrader Co., F. W.
Stackpole Carbon Co.
Stearns Magnetic, Inc.
Thumes Mek. Vaerksted, A. S.

MAPPING TOPOGRAPHIC, AERIAL & LAND—also see Exploration Service

Abrams Aerial Survey Corp.
Ammann Photogrammetric Engineers, Inc., Jack
Cummings Jr., & Associates, Robt. A.
Fairchild Aerial Surveys, Inc.
Hycon Aerial Surveys, Inc.
Manu-Mine Research & Devel. Co.
Photographic Survey Corp., Ltd.
Spartan Air Services, Ltd.

METALLIZING EQUIPMENT & SUPPLIES

Metallizing Engineering Co., Inc.

METERS & GAGES, INDICATING & MEASURING DEVICES & INSTRUMENTS (Remote, Recording, etc.)—see specific type below, also see Controls; Geophysical Instruments; Communications, Television

METERS & GAGES, ETC., CHEMICAL: pH, et al.—also see Gas; Humidity & Detectors; Indicators; Meters, Liquid Density

Analytical Measurements, Inc.
Bailey Meter Co.
Beckman Instruments, Inc.
Braun Corp.
Bristol Co.
Cambridge Instruments Co., Inc.
Curtiss-Wright Corp.
Electronics Div.
Foxboro Co.
Industrial Physics & Electronics Co.
Leeds & Northrup Co.
Macbeth Daylighting Corp.
Matheson Co., Inc.
Minneapolis-Honeywell Regulator Co.
Minneapolis-Honeywell Regulator Co.
Industrial Div.
Taylor & Co., W. A.
Thwing-Albert Instrument Co.
Van Waters & Rogers, Inc.

METERS & GAGES, ETC., ELECTRICITY

American Machine & Metals, Inc.
Atlas Powder Co.
Braun Corp.
Bristol Co.
Cambridge Instruments Co., Inc.
Columbia Electric Mfg. Co.
Consolidated Electrodynamics Corp.
DuPont de Nemours & Co., E. I.
Engelhard, Inc., Charles
Esterline-Angus Co., Inc.
General Electric Co.
Apparatus Sales Div.
Graybar Elec. Co., Inc.
Gray Instrument Co.
Heiland Div.
Minneapolis Honeywell
International General Electric Co.
Jarrell-Ash Co.
Knopp, Inc.
Leeds & Northrup Co.
Minneapolis-Honeywell Regulator Co.
Industrial Div.
National Powder Co.
Quick Charge, Inc.
Rawson Electrical Instrument Co.
Sangamo Electric Co.
Thwing-Albert Instrument Co.
Westinghouse Electric Corp.
Weston Electrical Instrument Corp.
Subsidiary of Daystrom, Inc.

METERS & GAGES, ETC., FLUID: FLOW, PRESSURE & VACUUM—also see Gas (& Moisture) Detectors & Indicators; Meters, Chemical; Meters, Liquid Density

American Chain & Cable Co., Inc.
Helicoid Gage Div.
American Machine & Metals, Inc.
U. S. Gauge Div.
Bailey Meter Co.
Batson Electronics Corp., J. A.
B-I-F Industries
Builders-Providence Div.
Braun Corp.
Bristol Co.
Central Scientific Co.
Clapp Instrument Co.
Consolidated Electrodynamics Corp.
Crosby Steam Gage & Valve Co.
Davis Instrument Co.
Diamond Power Specialty Co.
Dietz Co., Henry G.
Coral Designs Div.
Elliott Co., B. K.
Esterline-Angus Co., Inc.
Fisher & Porter Co.
Foxboro Co.
General Electric Co.
Apparatus Sales Div.
Gray Instrument Co.
Graybar Elec. Co., Inc.
Gurley, W. & L. E.
Hagen Corp.
Illinois Testing Laboratories, Inc.
Industrial Physics & Electronics Co.
Lonergan Co., J. E.
Matheson Co., Inc.
Meriam Instrument Co.
Minneapolis-Honeywell Regulator Co.
Minneapolis-Honeywell Regulator Co.
Industrial Div.
Mine Safety Appliances Co.
National Mine Service Co.
New Jersey Meter Co.
Norden-Ketay Corp.
Revere Corp. of America
Schutte & Koerting Co.
Taylor Instrument Co.
Uehling Instrument Co.
Victor Equipment Co.
Westinghouse Air Brake Co.
Ind. Products Div.
Weston Electrical Instrument Corp.
Subsidiary of Daystrom, Inc.
Wilkerson Corp.
Willson Products Div.
Ray-O-Vac Co.

METERS & GAGES ETC., LIQUID (& SLURRY) DENSITY—also see Meters, Chemical; Meters, Fluid

Bristol Co.
Fairmont Machinery Co.
Fisher & Porter Co.
Foxboro Co.
Industrial Physics & Electronics Co.
Mine & Smelter Supply Co.
Marcy Mill Div.

Minneapolis-Honeywell Regulator Co.
Industrial Div.
Nuclear Research Corp.
Precision Thermometer & Instrument Co.

METERS & GAGES, ETC., TEMPERATURE
American Machine & Metals, Inc.
U. S. Gauge Div.
Bailey Meter Co.
B-I-F Industries
Builders-Providence Div.
Blue M Electric Co.
Braun Corp.
Bristol Co.
Cambridge Instruments Co., Inc.
Davis Instrument Co.
Engelhard, Inc., Charles
Fisher & Porter Co.
Foxboro Co.
General Electric Co.
Apparatus Sales Div.
H-B Instrument Co., Inc.
Illinois Testing Laboratories, Inc.
Industrial Physics & Electronics Co.
Leeds & Northrup Co.
Minneapolis-Honeywell Regulator Co.
Minneapolis-Honeywell Regulator Co.
Industrial Div.
Precision Thermometer & Instrument Co.
Republic Flow Meters Co.
Thwing-Albert Instrument Co.
Weston Electrical Instrument Corp.
Subsidiary of Daystrom, Inc.
Wheelco Instr. Div.
Barber-Colman Co.

METERS & GAGES, ETC., WEIGHT & FORCE—see Scales

MILL BALLS & SIMILAR GRINDING MEDIA
Allis Chalmers Mfg. Co.
General Machinery Div.
American Brake Shoe Co.
American Forge Co.
Bethlehem Steel Co., Inc.
Braun Corp.
Calumet Div.
Calumet & Hecla, Inc.
Coates Steel Prod. Co.
Colorado Fuel & Iron Corp.
Wickwire Spencer Steel Div.
Coors Porcelain Co.
Denver Equipment Co.
Eastern Electro-Casting Co., Ltd.
Endicott Forging & Mfg. Co.
Foster Wheeler Corp.
Hardinge Co., Inc.
International Nickel Co.
Kennedy-Van Saun Mfg. & Eng. Corp.
National Malleable & Steel Castings Co.
Patterson Foundry & Machine Co.
Sheffield Steel Div.
Armco Steel Corp.
Stearns Roger Mfg. Co.
Tennessee Coal & Iron Div.
U. S. Steel Corp.
Treadwell Engineering Co.
U. S. Steel Corp.
Columbia-Geneva Steel Div.

MILL GRINDING RODS
Allis Chalmers Mfg. Co.
General Machinery Div.
American Forge Co.
Baldwin-Lima-Hamilton Corp.
Standard Steel Works Div.
Bethlehem Pacific Coast Steel Corp.
Bethlehem Steel Co., Inc.
Colorado Fuel & Iron Corp.
Colorado Fuel & Iron Corp.
Wickwire Spencer Steel Div.
Denver Equipment Co.
Dominion Engineering Co., Ltd.
Hardinge Co., Inc.
International Nickel Co.
Kennedy-Van Saun Mfg. & Eng. Corp.
Patterson Foundry & Machine Co.
Sheffield Steel Div.
Armco Steel Corp.
Stearns Roger Mfg. Co.
Tennessee Coal & Iron Div.
U. S. Steel Corp.

MILL LINERS
Allis Chalmers Mfg. Co.
General Machinery Div.
American Brake Shoe Co.
American Brake Shoe Co.
American Steel Div.
American Steel Foundries
Baldwin-Lima-Hamilton Corp.
Standard Steel Works Div.
Bethlehem Steel Co., Inc.
Calumet Div.
Calumet & Hecla, Inc.
Coeur d'Alene Hardware & Foundry Co.
Coors Porcelain Co.
Denver Equipment Co.
Elmco Corp.
Electric Steel Foundry Co.
Frog, Switch & Mfg. Co.
Hardinge Co., Inc.
Kennedy-Van Saun Mfg. & Eng. Corp.
Kensington Steel Co.
Linatex Corp. of America
Manganese Steel Forge Co.
McNally Pittsburg Mfg. Corp.
National Malleable & Steel Castings Co.
Patterson Foundry & Machine Co.
Sheffield Steel Co.
Smidth & Co., F. L.
Sorel Steel Foundries, Ltd.
Stearns Roger Mfg. Co.
Taylor-Wharton Co. Div.
Harsco Corp.
Thomas Foundries, Inc.
U. S. Steel Corp.
Columbia-Geneva Steel Div.

MILL SHELLS
Allis Chalmers Mfg. Co.
General Machinery Div.
Baldwin-Lima-Hamilton Corp.
Standard Steel Works Div.
Denver Equipment Co.
Hardinge Co., Inc.
Midvale—Heppenstall
Stearns Roger Mfg. Co.

MILLS, GRINDING: BALL, PEBBLE, ROD, & TUBE
Aerofall Mills, Inc.
Allis Chalmers Mfg. Co.
General Machinery Div.
Allison Steel Mfg. Co.
Bico, Inc.
Birdsboro Steel Foundry & Machine Co.
Black's Machine Shop
Braun Corp.
Denver Equipment Co.
Dominion Engineering Co., Ltd.
Dravo Corp.
Elmco Corp.
Fahrenwald Co., A. W.
Foster Wheeler Corp.
Gallgher Co.
Hardinge Co., Inc.
Hirsch Bros. Machy. Co.
Kennedy-Van Saun Mfg. & Eng. Corp.
McNally Pittsburg Mfg. Corp.
Mine & Smelter Supply Co.
Marcy Mill Div.
Morse Bros. Machinery Co.
Nordberg Mfg. Co.
Patterson Foundry & Machine Co.
Smidth & Co., F. L.
Standard Steel Corp.
Stearns Roger Mfg. Co.
Straub Mfg. Co.
Tema, N. V.
Traylor Engineering & Mfg. Co.
Union Iron Works
Vulcan Iron Works
Western Machinery Co.

MILLS, PORTABLE & MOVABLE (Complete Ore Dressing)—also see Crushers, Portable
Denver Equipment Co.
Western Machinery Co.

MINE CARS—see Cars, Mine

MINE DOORS, AUTOMATIC
American Mine Door Co.
Coeur d'Alene Hardware & Foundry Co.
McKiernan-Terry Corp.

MINE SUPPORTS, METAL—also see Steel
Acme Machinery Co.
Allison Steel Mfg. Co.
Armco Drainage & Metal Products, Inc.
Bethlehem Pacific Coast Steel Corp.
Commercial Shearing & Stamping Inc.
Lakeside Bridge & Steel Co.
Mayo Tunnel & Mine Equipment Co.
Truscon Steel Co. Div.
Republic Steel Corp.
Wisconsin Bridge & Iron Co.

MINERALS, DEALERS & SALES AGENTS
American Metal Co.
American Smelting & Refining Co.
American Zinc Sales Co.
Associated Metals & Minerals Corp.
Baker & Co., Inc.
Brandeis, Goldschmidt & Co., Inc.
Buck Inc., Leonard J.
Calabrian Co., Inc.
Continental Mineral Processing Co.
Continental Ore Corp.
DeSousa Co., Inc., J. E.
Foote Mineral Co.
Godoy & Co., E. A.
Grace & Co., W. R.
Haesler Metal & Ore Corp.
International Minerals & Metals Corp.
Metal Traders Inc.
Minerais et Metaux
Muller & Co., Inc., Wm. H.
Overseas Raw Materials Corp.
Philipp Bros. Inc.
Reynolds Overseas
Rodriguez & Gillespie Co.
Strauss & Co., Inc., A.
Tennant Sons & Co., C. of N. Y.
Texas Gulf Sulphur Co.
U. S. Smelting, Refining & Mining Co., Inc.
Vale Do Rio Doce Trading Co., Inc.
Wah Chang Corp.

MONITOR, HYDRAULIC (WATER)
Chiksan Co.
Georgia Iron Works Co.
Johnson Mfg. Co., Inc.

MOTOR-GENERATOR & ENGINE-GENERATOR SETS—see Electric Generators
Allis-Chalmers Mfg. Co.
Buda Div.
Allis Chalmers Mfg. Co.
General Machinery Div.
Allis Co., Louis
Caterpillar Tractor Co.
Century Electric Co.
Columbia Electric Mfg. Co.
Continental Electric Co.
Cooper-Bessemer Corp.
Detroit Diesel Engine Div.
General Motors Corp.
Diesel Energy Corp.
Electric Machinery Mfg. Co.
Electric Specialty Co.
Elliott Co.
Ridgway Div.
Fairbanks-Morse & Co.
General Electric Co.
Apparatus Sales Div.
General Electric Co.
Ind. Haulage Div.—Loco. & Car Equip. Divs.
Hertner Electric Co.
Hobart Bros. Co.
Ideal Electric & Mfg. Co.
Imperial Electric Co.
International General Electric Co.
Kato Engineering Co.
Klockner-Humboldt-Deutz Ag.
c/o Diesel Energy Corp.
Kurz & Root Co.
Leach Corp.
Leland Electric Div.
American Machine & Foundry Co.
Le Roi Div.
Westinghouse Air Brake Co.
Lister-Blackstone, Inc.
Marathon Electric Mfg. Corp.
Miehle Printing Press & Mfg. Co.
Star-Kimble Motor Div.
Northwestern Electric Co.
Onan & Sons, Inc., D. W.
Prescott Co.—Sterling Engine Co.
Reliance Electric & Engineering Co.
Sangamo Electric Co.
Sheppard Co., Inc., R. H.
Troy Engine & Machine Co.
U. S. Motors Corp.
Universal Motor Co.
Westinghouse Electric Corp.
White Diesel Engine Div.
White Motor Co.
Witte Engine Works
Oil Well Supply Div.
U. S. Steel Corp.
Worthington Corp.

MUCKING MACHINES—see Loaders
Elmco Corp.
Gardner Denver Co.
Myers-Whaley Co., Inc.
Sanford-Day Iron Works, Inc.
Sanford-Day Iron Works
Brown-Fayro Div.
Shaft & Development Machines Co.

NODULIZING & BRIQUETTING EQUIPMENT—also see Sintering Equipment
Link-Belt Co.

NOZZLES
Bete Fog Nozzle, Inc.
Binks Mfg. Co.
Blaw-Knox Co.
Blaw-Knox Bldg.
Booth Co.
Boston Woven Hose & Rubber Co.
Chain Belt Co.
Deister Concentrator Co.
Deister Machine Co.
Dixon Crucible Co., Joseph
Elkhart Brass Mfg. Co.
Fairmont Machinery Co.
Fyr-Fyter Co.
Hydraulic Supply Mfg. Co.
Iowa Mfg. Co.
Link-Belt Co.
Meckum Engineering, Inc.
Nathan Mfg. Co.
Schutte & Koerting Co.
Spray Engineering Co.
Victor Equipment Co.
Yarnall-Waring Co.
Zurn Mfg. Co., J. A.

OFFICE MACHINES & EQUIPMENT
Remington Rand Div.
Sperry Rand Corp.

ORE, CONCENTRATE, ETC., SAMPLERS (MECHANICAL)
Bennetts Chemical Laboratory, Inc.
Colorado Iron Works
Dagley Mfg. Co.
Denver Equipment Co.
Gallgher Co.
Hardinge Co., Inc.
Houston Tool Co., Inc.
Jarrell-Ash Co.
Ledoux & Co.
Mine & Smelter Supply Co.
Marcy Mill Div.

PACKING
Belmont Packing & Rubber Co.
Garlock Packing Co.
Gatke Corp.
Gilmer Co., L. H.
Goodall Rubber Co.
Goodrich Industrial Products Co., B. F.
Goodyear Tire & Rubber Co.
Graton & Knight Co.
Greene Tweed Co.
Hewitt-Robins, Inc.
Houghton & Co., E. F.
Johns-Manville
MacClatchie Mfg. Co.
New York Belting & Packing Co.
Philadelphia Belting Co.
Porter Co., H. K.
Quaker Pioneer Rubber Div.
Raybestos-Manhattan, Inc.
Manhattan Rubber Div.
Republic Rubber Div.
Lee Rubber & Tire Corp.
Rhoads & Son, J. E.
Schieren Co., Charles A.
Snyder & Son, Inc., M. L.
Thermoid Co.
Industrial Div.
United States Rubber Co.
New York Belting & Packing Co. Div.

PETROLEUM PRODUCTS—also see Lubricants
Borne Scrymser Co.
Brooks Oil Co.
Drullard Co., Howard
Esso Standard Oil Co.
Gulf Oil Corp.
Gulf Refining Co.
Hulburt Oil & Grease Co.
Jesco Lubricants Co.
Jet-Lube, Inc.
Keystone Lubricating Co.
Lockrey Co.
Macmillan Petroleum Corp.
New York & New Jersey Lubricant Co.
Phillips Petroleum Co.
Pure Oil Co.
Southwestern Petroleum Co.
Standard Oil Co. of California
Western Div.
Standard Oil Co.—Indiana
Utah Oil Refining Co.
Valvoline Oil Co. Div.
Ashland Oil & Refining Co.

pH INDICATORS—see Meters, Chemical

PIPE—see specific type below; also see Electrical Conduit; or Tubing, Metal

PIPE, IRON & STEEL
Alco Products, Inc.
Allegheny Ludlum Steel Corp.
American Cast Iron Pipe Co.
Armco Drainage & Metal Products, Inc.
Bethlehem Steel Co., Inc.
Byers Co., A. M.
Chattanooga Boiler & Tank Co.
Colorado Fuel & Iron Corp.
Wickwire Spencer Steel Div.
Crucible Steel Co. of America
Dominion Steel & Coal Corp., Ltd.
Foster Co., L. B.
Goyne Steam Pump Co.
Graybar Elec. Co., Inc.
Jones & Laughlin Steel Corp.
Kellogg Co., M. W.
National Supply Co.
Naylor Pipe Co.
Oaden Iron Works
Ryerson & Son, Inc., Joseph T.
Sikorsky Division
United Aircraft Co.
Springfield Boiler Co.
Swepco Tube Corp.
Taylor Forge & Pipe Works

Union Carbide & Carbon Corp.
Haynes Stellite Co. Div.
U. S. Pipe & Foundry Co.
U. S. Steel Corp.
Columbia-Geneva Steel Div.
U. S. Steel Corp.
National Tube Div.
United States Steel Supply Co.
Victaulic Co. of America
Wheeling Steel Corp.
Youngstown Sheet & Tube Co.

PIPE, NONFERROUS METAL
Aluminum Co. of America
Ampco Metal, Inc.
Belmont Smelting & Refining Works, Inc.
Chase Brass & Copper Co.
Chattanooga Boiler & Tank Co.
Foster Co., L. B.
Goyne Steam Pump Co.
Graybar Elec. Co., Inc.
International Nickel Co.
Kaiser Aluminum & Chemical Sales, Inc.
Mueller Brass Co.
National Lead Co.
Phelps Dodge Copper Products Corp.
Rem Cru Titanium, Inc.
Revere Copper & Brass, Inc.
Reynolds Metals Co.
Triangle Conduit & Cable Co.
Wolverine Tube Div.
Calumet & Hecla, Inc.
Wright Engineering & Supply Co.
New Products Development

PIPE (METAL), NON-METALLIC LINED
American Hard Rubber Co.
Galigher Co.
Goodrich Industrial Products Co., B. F.
Graybar Elec. Co., Inc.
Johns-Manville
Keasbey & Mattison Co.
Linatex Corp. of America
Luzerne Rubber Co.
Porter Co., H. K.
Quaker Pioneer Rubber Div.

PIPE, PLASTIC
American Hard Rubber Co.
Anchor Plastics Corp.
Carlon Products Corp.
Continental-Diamond Fibre Div.
Budd Inc.
Corning Glass Works
Crane Co.
Federal Pipe & Tank Co.
Franklin Plastics Co.
Goodrich Co., B. F.
Flat Belting
Goodrich Industrial Products Co., B. F.
Graybar Elec. Co., Inc.
Hales Co., W. M.
Hamilton Rubber Mfg. Corp.
Johnson Plastic Corp.
Luzerne Rubber Co.
M & M Woodworking Co.
National Tank & Pipe Div.
Mueller Brass Co.
National Vulcanized Fibre Co.
Plastex Pipe & Extrusion Co.
Porter Co., H. K.
Quaker Rubber Co. Div.
Republic Steel Corp.
Ryerson & Son, Inc., Joseph T.
Synthane Corp.
Triangle Conduit & Cable Co.
U. S. Steel Corp.
Columbia-Geneva Steel Div.
U. S. Steel Corp.
National Tube Div.
Wellohn Plastics Co.
Industrial Div.
Youngstown Sheet & Tube Co.

PIPE, VENTILATION—see Ventilation Pipe

PIPE, WOOD
Acme Tank Mfg. Co.
Arrow Tank Co.
Caldwell Co., W. E.
Federal Pipe & Tank Co.
Hauser-Stander Tank Co.
M & M Woodworking Co.
National Tank & Pipe Div.
Michigan Pipe Co.
Pacific Wood Tank Corp.
Santa Fe Tank & Tower Co.
Sutphen, Peter O.
Windeler Co., Ltd., George

PIPE FITTINGS—also see Nozzles; Traps; or Valves
ACF Industries, Inc.
Alco Products, Inc.
American Cast Iron Pipe Co.
Ampco Metal, Inc.
Blaw-Knox Co.
Carlon Products Corp.
Catawissa Valve & Fittings Co.
Chase Brass & Copper Co.
Crane Co.
Dominion Steel & Coal Corp., Ltd.
Dresser Mfg. Div.
Electrical Engineers Equipment Co.
Fairbanks Co.
Federal Pipe & Tank Co.
Franklin Plastics Co.
Goyne Steam Pump Co.
Grinnell Co., Inc.
Gustin-Bacon Mfg. Co.
Jefferson Union Co.
Johns-Manville
Lunkenheimer Co.
Luzerne Rubber Co.
MacClatchie Mfg. Co.
Malleable Iron Fittings Co.
Meckum Engineering, Inc.
Swan-Finch Oil Corp.
Texas Co.
Mueller Brass Co.
National Lead Co.
Naylor Pipe Co.
Sikorsky Division
United Aircraft Co.
Stockham Valves & Fittings
Swepco Tube Corp.
Taylor Forge & Pipe Works
Tube Turns Div.
National Cylinder Gas Co.
Union Carbide & Carbon Corp.
Haynes Stellite Co. Div.
U. S. Pipe & Foundry Co.
Victaulic Co. of America
Vogt Machine Co., Henry
Walworth Co.
Warren Foundry & Pipe Corp.
Weatherhead Co.
Fort Wayne Div.
J. A. Zurn Mfg. Co.

PLANT CONSTRUCTION & DESIGN —also see Searchlight Section
Allen & Garcia Co.
Arrowhead Steel Buildings, Inc.
Blaw-Knox Co.
Booth Co.
Braun & Co., C. F.
Carpco Manufacturing, Inc.
Catalytic Construction Co.
Chemical Construction Corp.
Custodis Construction Co., Inc.
Daniels Co. Contractors, Inc.
Denver Equipment Co.
Dorr-Oliver Inc.
Fairmont Machinery Co.
Fitz Simons & Connell Dredge & Dock Co.
Foley Bros. Construction Co.
Frazier Davis Const. Co.
Fuel Process Co.
Heyl & Patterson, Inc.
Industrial Engrg. & Construction Co.
Kaiser Engineers
Kanawha Mfg. Co.
Kellogg Co., M. W.
McGraw & Co., F. H.
McKee & Co., Arthur G.
National Iron Co.
Southwestern Engineering Co.
Stearns Roger Mfg. Co.
Stone & Webster Engineering Co.
Snyder Mine & Chemical Lab.
Thompson-Starrett Co., Inc.
Roberts & Schaefer Co. Div.
Turner Construction Co.
Union Iron Works
Vitro Corp. of America
Walvoord, Inc., O. W.
Western Machinery Co.
Williams & Green
Wilmot Engineering Co.

PNEUMATIC . . . —see Air . . .

POWER PLANTS—see Electric Generators
Condenser Service & Engineering Co.
Dravo Corp.
General Electric Co.
Ind. Haulage Div.—Loco. & Car Equip. Divs.
Graybar Elec. Co., Inc.
Hobart Bros. Co.
International General Electric Co.
Lincoln Electric Co.
Onan & Sons, Inc., D. W.
Ready Power Co.
Stearns Roger Mfg. Co.
U. S. Motors Corp.
Universal Motor Co.
Westinghouse Electric Corp.
Wickes Boiler Co. Div.
Wickes Corp.

POWER SHOVELS—also see Cranes; Dipper Shovels; or Draglines
American Hoist & Derrick Co.
Baldwin-Lima-Hamilton Corp.
Construction Equipment Div.
Bay City Shovels, Inc.
Bucyrus-Erie Co.
Caterpillar Tractor Co.
Dominion Engineering Co., Ltd.
Eimco Corp.
Electric Steel Foundry Co.
Harnischfeger Corp.
P & H Diesel Div.
Koehring Co.
Link-Belt Speeder Corp.
Manitowoc Engineering Corp.
Marion Power Shovel Co.
Michigan Power Shovel Co.
Quick-Way Truck Shovel Co.
Schield Bantam Co.
Sorel Steel Foundries, Ltd.
Thew Shovel Co.
Unit Crane & Shovel Corp.

POWER TAKE-OFFS—also see Drives
Allen-Sherman-Hoff Pump Co.
American-Marsh Pumps, Inc.
Diamond Chain Co., Inc.
Drilling Accessory & Mfg. Co., Inc.
Fourwheel Drive Auto Co.
Gar Wood Industries, Inc.
Hendrickson Mfg. Co.
Mayhew Machine & Supply Co.
McGowan Pump Div.
Leyman Mfg. Corp.
Rockwell Spring & Axle Co.
Timken-Detroit Axle Div.
Stimmel Winch Co., Inc.
Twin Disc Clutch Co.
Western Gear Corp.

PROFESSIONAL SERVICES—see Searchlight Section

PULLEYS—see Blocks

PULLEYS, MAGNETIC—also see Separators, Magnetic
Dings Magnetic Separator Co.
Eriez Mfg. Co.
Homer Mfg. Co.
Link-Belt Co.
Ohio Electric Mfg. Co.
Recoveries, Inc.
Schrader Co., F. W.
Stearns Magnetic, Inc.
Stearns Roger Mfg. Co.

PULVERIZERS
Bico, Inc.
Bradley Pulverizer Co.
Combustion Engineering Inc.
Combustion Engineering Inc.
Raymond Div.
Gruendler Crusher & Pulverizer Co.
Jeffrey Mfg. Co.
Kennedy-Van Saun Mfg. & Eng. Corp.
Majac Inc.
Mead Mill Co.
Metals Disintegrating Co., Inc.
Pulverizing Machinery Div.
Mine & Smelter Supply Co.
Marcy Mill Div.
Morse Bros. Machinery Co.
Pulva Corp.
Rogers Iron Works Co.
Smidth & Co., F. L.
Smith Engineering Works
Stearns Roger Mfg. Co.
Sturtevant Mill Co.
Whiting Corp.
Williams Patent Crusher & Pulverizer Co.

PUMP ACCESSORIES
American-Marsh Pumps, Inc.
Barrett Haentjens & Co.
Erie Pump & Engine Works
Flood City Brass & Elec. Co.
Goyne Steam Pump Co.
Hills-McCanna Co.
Jacuzzi Bros., Inc.
Lancaster Pump & Mfg. Co.
Longyear Co., E. J.
MacClatchie Mfg. Co.
New York Air Brake Co.

PUMPS, AIR DRIVEN
Aldrich Pump Co.
Atlas Copco Eastern, Inc.
Chicago Pneumatic Tool Co.
Dominion Engineering Co., Ltd.
Dorr-Oliver, Inc.
Gardner-Denver Co.
Gray & Co., Inc.
Leeden Mfg. Co.
Lincoln Engineering Co.
Longyear Co., E. J.
Penberthy Injector Co.
Reed Roller Bit Co.
Schramm, Inc.
Stewart-Warner Corp.
Alemite Div.
Warren Steam Pump Co.
Westinghouse Air Brake Co.
Cleveland Rock Drill Plant, Le Roi Div.
Worthington Corp.

PUMPS, CENTRIFUGAL & TURBINE
Allis Chalmers Mfg. Co.
General Machinery Div.
American Brake Shoe Co.
American-Marsh Pumps, Inc.
American Well Works
Ampco Metal, Inc.
Barnes Mfg. Co.
Barrett Haentjens & Co.
Bingham Pump Co.
Buffalo Forge Co.
Carter Co., Ralph B.
Carver Pump Co.
Chain Belt Co.
Construction Machy. Co.
Davidson Co., M. T.
Dean Hill Pump Co.
DeLaval Steam Turbine Co.
Deming Co.
Dominion Engineering Co., Ltd.
Dorr-Oliver Inc.
Fairbanks-Morse & Co.
Flood City Brass & Elec. Co.
Food Machinery & Chemical Corp.
Peerless Pump Div.
Gardner-Denver Co.
Gorman Rupp Co.
Goulds Pumps, Inc.
Goyne Steam Pump Co.
Homelite Corp.
Ingersoll-Rand Co.
Jaeger Machine Co.
Krogh Pump & Equipment Co.
LaBour Co.
Lancaster Pump & Mfg. Co.
Lawrence Pumps, Inc.
Layne & Bowler Pump Co. of Los Angeles
Lecourtenay Co.
Luzerne Rubber Co.
Maddox Foundry & Machine Works, Inc.
McDonald Mfg. Co. A. Y.
McNally Pittsburg Mfg. Corp.
Mission Mfg. Co.
Morris Machine Works
New York Air Brake Co.
Aurora Pump Div.
New York Air Brake Co.
Hydraulic Div.
Novo Pump & Engine Co.
Pennsylvania Pump & Compressor Co.
Prescott Co.—Sterling Engine Co.
Rice Pump & Machine Co.
Schneible Co., Claude B.
Smith Co., A. O.
Standard Elec. Mfg. Co., Inc.
Swaby Mfg. Co.
Warren Steam Pump Co.
Weinman Pump Mfg. Co.
Western Machinery Co.
Wheeler Mfg. Co., C. H.
Wilfley & Sons, A. R.
Worthington Corp.
Wintroath Pumps Div.
Worthington Corp.
Yuba Manufacturing Co.

PUMPS (& BLOWERS), CONCRETE GROUTING & PLACING
Cement Gun Co.
Chain Belt Co.
Drilling Accessory & Mfg. Co., Inc.
Gardner-Denver Co.
Krogh Pump & Equipment Co.
Lidgerwood Industries, Inc.
Longyear Co., E. J.
Mayhew Machine & Supply Co.
Mayo Tunnel & Mine Equipment Co.

PUMPS, CORROSIVE LIQUIDS
Aldrich Pump Co.
Allen-Sherman-Hoff Pump Co.
American-Marsh Pumps, Inc.
Ampco Metal, Inc.
Barnes Mfg. Co.
Barrett Haentjens & Co.
Bingham Pump Co.
Brosites Products Corp.
Buffalo Forge Co.
Construction Machy. Co.
Denver Equipment Co.
Dorr-Oliver, Inc.
Duriron Co., Inc.
Fairbanks-Morse & Co.
Food Machinery & Chemical Corp.
Peerless Pump Div.
Galigher Co.
Gardner-Denver Co.
Goulds Pumps, Inc.
Ingersoll-Rand Co.
Krogh Pump & Equipment Co.
LaBour Co.
Lawrence Pumps, Inc.
Layne & Bowler Pump Co. of Los Angeles
Lecourtenay Co.
Linatex Corp. of America
Lincoln Engineering Co.
Longyear Co., E. J.
Luzerne Rubber Co.
McGowan Pump Div.
Leyman Mfg. Corp.
McNally Pittsburg Mfg. Corp.
Naqle Pumps, Inc.
New York Air Brake Co.
New York Air Brake Co.
Aurora Pump Div.
Penberthy Injector Co.
Platt Iron Works
Prescott Co.—Sterling Engine Co.

Robbins & Myers, Inc.
Warren Steam Pump Co.
Weinman Pump Mfg. Co.
Western Machinery Co.
Wiffley & Sons, A. R.
Worthington Corp.
Wintroath Pumps Div.
Worthington Corp.

PUMPS, DEEP WELL & MINE

American-Marsh Pumps, Inc.
American Well Works
Barrett Haentjens & Co.
Fairbanks-Morse & Co.
Food Machinery & Chemical Corp.
Peerless Pump Div.
Gorman Rupp Co.
Ingersoll-Rand Co.
Jacuzzi Bros., Inc.
Johnston Pump Co.
Kobe, Inc.
Krogh Pump & Equipment Co.
Lancaster Pump & Mfg. Co.
Layne & Bowler Pump Co. of Los Angeles
Lecourtenay Co.
Marlow Pumps
McGowan Pump Div.
Leyman Mfg. Corp.
New York Air Brake Co.
Aurora Pump Div.
New York Air Brake Co.
Hydraulic Div.
Platt Iron Works
Prescott Co.—Sterling Engine Co.
Robbins & Myers, Inc.
Sanford-Day Iron Works, Inc.
Weinman Pump Mfg. Co.
Worthington Corp.
Wintroath Pumps Div.
Worthington Corp.

PUMPS, DIAPHRAGM

Barnes Mfg. Co.
Barrett Haentjens & Co.
Carter Co., Ralph B.
Carver Pump Co.
Construction Machy. Co.
Continental Rubber Works
Dagley Mfg. Co.
Denver Equipment Co.
Dorr-Oliver, Inc.
Elmco Corp.
Essick Manufacturing Co.
Gardner-Denver Co.
Garlock Packing Co.
Gorman Rupp Co.
Hamilton Rubber Mfg. Corp.
Jaeger Machine Co.
Komline-Sanderson Engineering Corp.
Marlow Pumps
McGowan Pump Div.
Leyman Mfg. Corp.
Morse Bros. Machinery Co.
Novo Pump & Engine Co.
Platt Iron Works
Rice Pump & Machine Co.
Shriver & Co., T.
Western Machinery Co.
Worthington Corp.

PUMPS, DREDGE—also see Pumps, Sand & Slime

Allen-Sherman-Hoff Pump Co.
American Brake Shoe Co.
American Brake Shoe Co.
American Steel Div.
Birdsboro Steel Foundry & Machine Co.
Erie Pump & Engine Works
Krogh Pump & Equipment Co.
Lawrence Pumps, Inc.
Mackum Engineering, Inc.
Nagle Pumps, Inc.
New York Air Brake Co.
Pettibone Mulliken Corp.
Robbins & Myers, Inc.
Thomas Foundries, Inc.
Worthington Corp.

PUMPS, HYDRAULIC FLUID

Aldrich Pump Co.
American Brake Shoe Co.
American Engineering Co.
American-Marsh Pumps, Inc.
Barrett Haentjens & Co.
Baughman Manufacturing Co., Inc.
Be-Ge Mfg. Co.
Blackhawk Mfg. Co.
Commercial Shearing & Stamping Inc.
Davidson Co., M. T.
Dominion Engineering Co., Ltd.
Gar Wood Industries, Inc.
Goulds Pumps, Inc.
Hales Co., W. M.
Hills-McCanna Co.
Johnson Mfg. Co., Inc.
Lecourtenay Co.
Ledeen Mfg. Co.
Longyear Co., E. J.
New York Air Brake Co.
Hydraulic Div.
Oilgear Co.
Oliver Iron & Steel Corp.
Owatonna Tool Co.
Penberthy Injector Co.
Platt Iron Works
Rockwell Mfg. Co.
Schroeder Brothers
Vickers, Inc.
Warren Steam Pump Co.
Wintroath Pumps Div.
Worthington Corp.
Worthington Corp.

PUMPS, HYDRAULIC RAM-TYPE

American-Marsh Pumps, Inc.
Be-Ge Mfg. Co.
Blackhawk Mfg. Co.
Commercial Shearing & Stamping Inc.
Dake Corp.
Hales Co., W. M.
Johnson Mfg. Co., Inc.
Ledeen Mfg. Co.
New York Air Brake Co.
Hydraulic Div.
Oilgear Co.
Owatonna Tool Co.
Skookum Co.
Worthington Corp.

PUMPS, PISTON & PLUNGER

Aldrich Pump Co.
American Engineering Co.
American-Marsh Pumps, Inc.
Barnes Mfg. Co.
Carter Co., Ralph B.
Davidson Co., M. T.
Deming Co.
Fairbanks-Morse & Co.
Flood City Brass & Elec. Co.
Gardner-Denver Co.
Goulds Pumps, Inc.
Harnischfeger Corp.
P & H Diesel Div.
Kobe, Inc.
Komline-Sanderson Engineering Corp.
Lancaster Pump & Mfg. Co.
Ledeen Mfg. Co.
Lincoln Engineering Co.
Longyear Co., E. J.
Mayhew Machine & Supply Co.
McDonald Mfg. Co., A. Y.
McGowan Pump Div.
Leyman Mfg. Corp.
National Mine Service Co.
New York Air Brake Co.
Novo Pump & Engine Co.
Oliver Corp.
A. B. Farquhar Div.
Platt Iron Works
Sanford-Day Iron Works, Inc.
Sanford-Day Iron Works
Brown-Fayro Div.
Warren Steam Pump Co.
Weinman Pump Mfg. Co.
Worthington Corp.

PUMPS, PRIMING

American-Marsh Pumps, Inc.
Barnes Mfg. Co.
Barrett Haentjens & Co.
Goulds Pumps, Inc.
Jaeger Machine Co.
LaBour Co.
Lawrence Pumps, Inc.
Marlow Pumps
McGowan Pump Div.
Leyman Mfg. Corp.
Eagle Pumps, Inc.
Nash Engineering Co.
New York Air Brake Co.
Penberthy Injector Co.
Westinghouse Air Brake Co.
Worthington Corp.

PUMPS, ROTARY DISPLACEMENT

American Engineering Co.
American-Marsh Pumps, Inc.
Chicago Pneumatic Tool Co.
DeLaval Steam Turbine Co.
Deming Co.
Fairbanks-Morse & Co.
Goulds Pumps, Inc.
Hypro Engineering Inc.
Nash Engineering Co.
New York Air Brake Co.
New York Air Brake Co.
Hydraulic Div.
Platt Iron Works
Porto Pump Inc.
Read Standard Corp.
Warren Steam Pump Co.
Worthington Corp.

PUMPS, SAND & SLIME

Allen-Sherman-Hoff Pump Co.
Allis Chalmers Mfg. Co.
General Machinery Div.
American Brake Shoe Co.
American Brake Shoe Co.
American Steel Div.
American-Marsh Pumps, Inc.
Barrett Haentjens & Co.
Carpco Manufacturing, Inc.
Chicago Pneumatic Tool Co.
Dagley Mfg. Co.
Denver Equipment Co.
Erie Pump & Engine Works
Fairbanks-Morse & Co.
Galigher Co.
Georgia Iron Works Co.
Goyne Steam Pump Co.
Krogh Pump & Equipment Co.
Lancaster Pump & Mfg. Co.
Lawrence Pumps, Inc.
Linatex Corp. of America
Maddox Foundry & Machine Works, Inc.
Marlow Pumps
McGowan Pump Div.
Leyman Mfg. Corp.
Morris Machine Works
Nagle Pumps, Inc.
New York Air Brake Co.
New York Air Brake Co.
Hydraulic Div.
Novo Pump & Engine Co.
Pettibone Mulliken Corp.
Platt Iron Works
Robbins & Myers, Inc.
Thomas Foundries, Inc.
Union Iron Works
Western Machinery Co.
Wiffley & Sons A. R.
Worthington Corp.
Yuba Manufacturing Co.

PUMPS, SUMP

Allen-Sherman-Hoff Pump Co.
American-Marsh Pumps, Inc.
Barnes Mfg. Co.
Barrett Haentjens & Co.
Buffalo Forge Co.
Carter Co., Ralph B.
Chicago Pneumatic Tool Co.
Davidson Co., M. T.
Deming Co.
Fairbanks-Morse & Co.
Galigher Co.
Gardner-Denver Co.
Gorman Rupp Co.
Goulds Pumps, Inc.
Holman Bros. (Canada), Ltd.
Ingersoll-Rand Co.
Jacuzzi Bros., Inc.
Johnston Pump Co.
Krogh Pump & Equipment Co.
Lancaster Pump & Mfg. Co.
Lawrence Pumps, Inc.
Layne & Bowler Pump Co. of Los Angeles
Marlow Pumps
McDonald Mfg. Co., A. Y.
McNally Pittsburg Mfg. Corp.
Morris Machine Works
Nagle Pumps, Inc.
New York Air Brake Co.
Aurora Pump Div.
New York Air Brake Co.
Hydraulic Div.
Penberthy Injector Co.
Reed Roller Bit Co.
Robbins & Myers, Inc.
Schramm, Inc.
Standard Elec. Mfg. Co., Inc.
Swabv Mfg. Co.
Thor Power Tool Co.
Warren Steam Pump Co.
Weinman Pump Mfg. Co.
Western Machinery Co.
Wheeler Mfg. Co., C. H.
Wintroath Pumps Div.
Worthington Corp.
Worthington Corp.

PUMPS, VACUUM

Allis Chalmers Mfg. Co.
General Machinery Div.
American-Marsh Pumps, Inc.
Barrett Haentjens & Co.
Bingham Pump Co.
Braun Corp.
Central Scientific Co.
Chicago Pneumatic Tool Co.
Consolidated Electrodynamics Corp.
Dorr-Oliver, Inc.
Eisler Engineering Co.
Fuller Co.
Gardner-Denver Co.
General American Transportation Corp.
Houston Tool Co., Inc.
Ingersoll-Rand Co.
Jaeger Machine Co.
Joy Mfg. Co.
McGowan Pump Div.
Leyman Mfg. Corp.
Nash Engineering Co.
New York Air Brake Co.
New York Air Brake Co.
Hydraulic Div.
Penberthy Injector Co.
Pennsylvania Pump & Compressor Co.
Platt Iron Works
Read Standard Corp.
Robbins & Myers, Inc.
Sarco Co., Inc.
Schutte & Koerting Co.
Thumes Mek. Vaerksted, A. S.
U. S. Hoffman Machinery Corp.
Air Appliance Div.
Warren Steam Pump Co.
Wheeler Mfg. Co., C. H.
Worthington Corp.

PYROMETERS—see Meters, Temperature

RADIATION DETECTORS

Atomic Research Corp.
Beckman Instruments, Inc.
Berkeley Div.
Braun Corp.
Cambridge Instruments Co., Inc.
Carpco Manufacturing, Inc.
Colorado Assaying Co.
Curtiss-Wright Corp.
Electronics Div.
Detectron Corp.
Electronic Products Co.
El-Tronics Inc.
Engineers Syndicate, Ltd.
Fisher Research Laboratory, Inc.
General Electric Co.
Apparatus Sales Div.
General Nuclear Corp.
Geophysical Instrument & Supply Co.
Goldak Co., Inc.
International General Electric Co.
Jeb Instruments Co.
Ken Research, Inc.
La Roe Instruments, Inc.
Leeds & Northrup Co.
Menlo Research Laboratory
Minerals Engineering Co.
Mt. Sopris Instrument Co.
North American Phillips Co.
Nuclear Instrument & Chemical Corp.
Nuclear Research Corp.
Nucleonic Corp. of America
Precision Radiation Instruments, Inc.
Radiac Co., Inc.
Radiation Counter Laboratories
Sherwin Instrument Co.
Special Instruments Laboratory, Inc.
Technical Associates
Tracerlab, Inc.
Universal Atomics Corp.
Van Waters & Rogers, Inc.
Victoreen Instrument Co.
Western Radiation Laboratory
Whites Electronics

RADIO—See Communications

RAIL & TRACK

American Brake Shoe Co.
Bethlehem Pacific Coast Steel Corp.
Bethlehem Steel Co., Inc.
Card Iron Works, C. S.
Colorado Fuel & Iron Corp.
Colorado Fuel & Iron Corp.
Wickwire Spencer Steel Div.
Dominion Steel & Coal Corp., Ltd.
Forker Corp.
Foster Co., L. B.
Gibraltar Equipment & Mfg. Co.
Hales Co., W. M.
Inland Steel Co.
Sweet's Steel Co.
Tennessee Coal & Iron Div.
U. S. Steel Corp.
U. S. Steel Corp.
Columbia-Geneva Steel Div.
West Virginia Steel & Mfg. Co.

RAIL & TRACK ACCESSORIES—also see specific item under Rail . . . or Track . . .

American Brake Shoe Co.
Bethlehem Pacific Coast Steel Corp
Bethlehem Steel Co., Inc.
Card Iron Works, C. S.
Colorado Fuel & Iron Corp.
Conley Frog & Switch Co.
Dominion Steel & Coal Corp., Ltd.
Forker Corp.
Foster Co., L. B.
Gibraltar Equipment & Mfg. Co.
Hanlon & Wilson Co.
Sweet's Steel Co.
Tennessee Coal & Iron Div.
U. S. Steel Corp
U. S. Steel Corp.
Columbia-Geneva Steel Div.
West Virginia Steel & Mfg. Co.

RAIL BENDERS

Aldon Co.
Foster Co., L. B.
Gibraltar Equipment & Mfg. Co.
Hales Co., W. M.
Utility Mine Equipment Co.
Watt Car & Wheel Co.
American Mine Door Co.

RAIL BONDS

Copperweld Steel Co.
Ensign Electric & Mfg. Co.
Erico Products, Inc.
Hales Co., W. M.
Hanlon & Wilson Co.
National Mine Service Co.
Ohio Brass Co.
Penn Machine Co.
Tennessee Coal & Iron Div.
U. S. Steel Corp.

U. S. Steel Corp.
Columbia-Geneva Steel Div.

RAIL BRACES
Bethlehem Pacific Coast Steel Corp.
Bethlehem Steel Co., Inc.
Braun Corp.
Card Iron Works, C. S.
Colorado Fuel & Iron Corp.
Wickwire Spencer Steel Div.
Conley Frog & Switch Co.
Coover Railroad Track Brace Co.
Foster Co., L. B.
Gibraltar Equipment & Mfg. Co.
Nolan Co.
Pettibone Mulliken Corp.
U. S. Steel Corp.
Columbia-Geneva Steel Div.
Weir Kilby Corp.

RAIL CLAMPS, FISHPLATES & TIEPLATES
Bethlehem Pacific Coast Steel Corp.
Bethlehem Steel Co., Inc.
Central Frog & Switch Co.
Colorado Fuel & Iron Corp.
Wickwire Spencer Steel Div.
Foster Co., L. B.
Gibraltar Equipment & Mfg. Co.
Inland Steel Co.
McKiernan-Terry Corp.
U. S. Steel Corp.
Columbia-Geneva Steel Div.
Weir Kilby Corp.
West Virginia Steel & Mfg. Co.
Williams & Green

RAIL DRILLS & PUNCHES
Foster Co., L. B.
Gibraltar Equipment & Mfg. Co.
Mine Safety Appliances Co.
Nordberg Mfg. Co.
Ohio Brass Co.

RAIL FROGS, SWITCHES & CROSSINGS
American Brake Shoe Co.
American Brake Shoe Co.
American Steel Div.
Bethlehem Pacific Coast Steel Corp.
Bethlehem Steel Co., Inc.
Card Iron Works, C. S.
Conley Frog & Switch Co.
Foster Co., L. B.
General Equipment & Mfg. Co.
Gibraltar Equipment & Mfg. Co.
Miner's Hardware Supply Co.
Pettibone Mulliken Corp.
U. S. Steel Corp.
Columbia-Geneva Steel Div.
Weir Kilby Corp.
Westinghouse Air Brake Co.
West Virginia Steel & Mfg. Co.

RAIL SIGNALS
American Mine Door Co.
Bethlehem Pacific Coast Steel Corp.
Canadian Industries Ltd.
General Equipment & Mfg. Co.
Miner's Hardware Supply Co.
Nachod & U. S. Signal Co.
Westinghouse Air Brake Co.

RAIL SPIKES
Bethlehem Pacific Coast Steel Corp.
Bethlehem Steel Co., Inc.
Colorado Fuel & Iron Corp.
Colorado Fuel & Iron Corp.
Wickwire Spencer Steel Div.
Dominion Steel & Coal Corp., Ltd.
Foster Co., L. B.
Gibraltar Equipment & Mfg. Co.
Inland Steel Co.
Jones & Laughlin Steel Corp.
Oliver Iron & Steel Corp.
Sheffield Steel Co.
Sheffield Steel Div.
Armco Steel Corp.
Tennessee Coal & Iron Div.
U. S. Steel Corp.
Youngstown Sheet & Tube Co.

RAIL TIES, STEEL
Bethlehem Pacific Coast Steel Corp.
Bethlehem Steel Co., Inc.
Central Frog & Switch Co.
Foster Co., L. B.
Gibraltar Equipment & Mfg. Co.
U. S. Steel Corp.
Columbia-Geneva Steel Div.
West Virginia Steel & Mfg. Co.

RAIL TURNTABLES
Atlas Car & Mfg. Co.
Bethlehem Pacific Coast Steel Corp.
Card Iron Works, C. S.
Foster Co., L. B.
Gibraltar Equipment & Mfg. Co.
Hardinge Co., Inc.

REAGENT FEEDERS
American Water Softener Co.
Brositos Products Corp.
Clarkson Co.
Dagley Mfg. Co.
Deister Machine Co.
Denver Equipment Co.
Frontier Industries, Inc.
Manzel Div.
Gallgher Co.
Infilco, Inc.
Jeffrey Mfg. Co.
Manzel Div.
Houdaille Industries, Inc.
Mine & Smelter Supply Co.
Marcy Mill Div.
Morse Bros. Machinery Co.
Omega Machine Co.
Syntron Co.
Union Iron Works
Western Machinery Co.

RECTIFIERS, MERCURY ARC
Allis Chalmers Mfg. Co.
General Machinery Div.
Federal Telephone & Radio Div.
International Telephone and Telegraph Corp.
General Electric Co.
Apparatus Sales Div.
General Electric Co.
Ind. Haulage Div.—Loco. & Car Equip. Divs.
General Nuclear Corp.
Graybar Elec. Co., Inc.
International General Electric Co.
Jarrell-Ash Co.

RECTIFIERS, SELENIUM
American Rectifier Co.
Electro Products Laboratories
Engelhard, Inc., Charles
Federal Telephone & Radio Div.
International Telephone and Telegraph Corp.
General Electric Co.
Apparatus Sales Div.
General Electric Co.
Ind. Haulage Div.—Loco. & Car Equip. Divs.
General Nuclear Corp.
Gould-National Batteries, Inc.
Graybar Elec. Co., Inc.
International General Electric Co.
International Resistance Co.
Kersey Mfg. Co., Inc.
Knopp, Inc.
Perkins Engineering Co.
Schrader Co., F. W.
Smith Co., A. O.
Syntron Co.
Westinghouse Air Brake Co.
Westinghouse Electric Corp.

REFRACTORIES, BRICK
Babcock & Wilcox Co.
Carborundum Co.
Refractories Div.
Corhart Refractories Co.
Corning Glass Works
Electro Refractories & Abrasives Corp.
General Refractories Co.
Green Firebrick Co., A. P.
Harbison-Walker Refractories Co.
Ironton Fire Brick Co.
Johns-Manville
Kaiser Aluminum & Chemical Sales, Inc.
Laclede-Christy Co., Div.
H. K. Porter Co., Inc.
Mexico Refractories Co.
Mullite Refractories Co.
North American Refractories Co.
Norton Co.
Quigley Co., Inc.
Union Carbide & Carbon Corp.
National Carbon Co. Div.
Walsh Refractories Corp.

REFRACTORIES, CASTABLE
Babcock & Wilcox Co.
Carborundum Co.
Refractories Div.
General Refractories Co.
Green Firebrick Co., A. P.
Harbison-Walker Refractories Co.
Ironton Fire Brick Co.
Johns-Manville
Laclede-Christy Co., Div.
H. K. Porter Co., Inc.
Mexico Refractories Co.
Mullite Refractories Co.
North American Refractories Co.
Pettinos, Inc., George F.
Quigley Co., Inc.
Samuel & Co., Inc., Frank
Sauereisen Cement Co.
Walsh Refractories Corp.

REFRACTORY CEMENT
Babcock & Wilcox Co.
Carborundum Co.
Carey Mfg. Co., Philip
Corhart Refractories Co.
Dixon Crucible Co., Joseph
Eagle-Picher Co.
Electro Refractories & Abrasives Corp.
Engelhard, Inc., Charles
General Refractories Co.
Green Firebrick Co., A. P.
Harbison-Walker Refractories Co.
Ironton Fire Brick Co.
Johns-Manville
Laclede-Christy Co., Div.
H. K. Porter Co., Inc.
Mexico Refractories Co.
Mullite Refractories Co.
Norton Co.
Pettinos, Inc., George F.
Quigley Co., Inc.
Samuel & Co., Inc., Frank
Sauereisen Cement Co.
Union Carbide & Carbon Corp.
National Carbon Co. Div.
Walsh Refractories Corp.

RESPIRATORS—see Safety Respirators

ROCK (& ROOF) BOLT ACCESSORIES
Palnut Co.

ROCK (& ROOF) BOLTS
Arro Expansion Bolt Co.
Bethlehem Pacific Coast Steel Corp.
Bethlehem Steel Co., Inc.
Colorado Fuel & Iron Corp.
Colorado Fuel & Iron Corp.
Wickwire Spencer Steel Div.
Drullard Co., Howard
Gibraltar Equipment & Mfg. Co.
Goodyear Tire & Rubber Co.
National Production Co.
Ohio Brass Co.
Oliver Iron & Steel Corp.
Pittsburgh Screw & Bolt Co.
Republic Steel Corp.
Sheffield Steel Co.
Sheffield Steel Div.
Armco Steel Corp.
Sika Chemical Corp.
Thor Power Tool Co.
West Virginia Steel & Mfg. Co.
Youngstown Sheet & Tube Co.

ROOF BOLTING MACHINES
Acme Machinery Co.
Chicago Pneumatic Tool Co.
Dooley Brothers
Fletcher & Co., J. H.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Oliver Iron & Steel Corp.
Penn Machine Co.
Thor Power Tool Co.
Westinghouse Air Brake Co.
Cleveland Rock Drill Plant, Le Roi Div.

ROOFING & SIDING, METAL—also see Buildings, Metal
Aluminum Co. of America
Arrowhead Steel Buildings, Inc.
Bethlehem Steel Co., Inc.
Butler Manufacturing Co.
Illinois Zinc Co.
Inland Steel Products Co.
International Nickel Co.
Kaiser Aluminum & Chemical Sales, Inc.
Mahon Co., R. C.
New Jersey Zinc Co.
Plasteel Products Corp.
Republic Steel Corp.
Truscon Steel Div.
Revere Copper & Brass, Inc.
Reynolds Metals Co.
Robertson Co., H. H.
Steel-Bilt Construction Co.
Tennessee Coal & Iron Div.
U. S. Steel Corp.
U. S. Steel Corp.
Columbia-Geneva Steel Div.
Wheeling Steel Corp.
Wisconsin Bridge & Iron Co.

ROOFING & SIDING, NON-METALLIC
Barrett Div.
Allied Chemical & Dye Corp.
Carey Mfg. Co., Philip
Flintkote Co.
Johns-Manville
Keasbey & Mattison Co.
Koppers Co., Inc.
Ruberoid Co.
Southwestern Petroleum Co.

RUST PREVENTATIVES—also see Coatings
American Sand-Banum Co., Inc.
Armour & Co.
Barrett Div.
Allied Chemical & Dye Corp.
Borne Scrymser Co.
Canadian Industries Ltd.
Carbolineum Wood Preserving Co.
Carey Mfg. Co., Philip
Dixon Crucible Co., Joseph
DuPont de Nemours & Co., E. I.
Gulf Oil Corp.
Gulf Refining Co.
Houghton & Co., E. F.
Industrial Metal Protectives, Inc.
Insul-Mastic Corp. of America
Keystone Lubricating Co.
Master Bronze Powder Co.
New York & New Jersey Lubricant Co.
Philadelphia Quartz Co.
Royston Laboratories
Rust-Oleum Corp.
Shell Oil Co.
Sonneborn Sons, Inc., L.
Standard Oil Co. of California
Western Div.
United States Steel Supply Co.
Valvoline Oil Co. Div.
Ashland Oil & Refining Co.
Wilbur & Williams Co.

SAFETY CLOTHING, HATS, BELTS, GLOVES & SHOES
American Optical Co.
Bullard Co., E. D.
Charleston Rubber Co.
Goodall Rubber Co.
Holtite Mfg. Co.
Industrial Gloves Co.
International Shoe Co.
Johns-Manville
Judson Rubber Works, Inc.
Keasbey & Mattison Co.
Klein & Sons, Mathias
Lehigh Safety Shoe Co.
Mine Safety Appliances Co.
Mitchell Mfg. Co.
National Mine Service Co.
Parker Safety Equipment Co.
Penn Mfg. & Supply Co.
Pulmosan Safety Equipment Corp.
Rose Mfg. Co.
Safety Clothing & Equipment Co.
Safety First Shoe Co.
Safety First Supply Co.
Snyder & Son, Inc., M. L.
Southern Oxygen Co.
Welsh Mfg. Co.
Willson Products Div.
Ray-O-Vac Co.

SAFETY GOGGLES & MASKS
American Optical Co.
Bausch & Lomb Optical Co.
Bullard Co., E. D.
Chicago Eye Shield Co.
Flexo Products, Inc.
Goggle Parts Co.
Mine Safety Appliances Co.
Parker Safety Equipment Co.
Pulmosan Safety Equipment Corp.
Safety First Supply Co.
Sellstrom Mfg. Co.
Southern Oxygen Co.
U. S. Safety Service Co.
Welsh Mfg. Co.
Willson Products Div.
Ray-O-Vac Co.

SAFETY RESPIRATORS
American Optical Co.
Bullard Co., E. D.
Chicago Eye Shield Co.
Flexo Products, Inc.
Mine Safety Appliances Co.
Parker Safety Equipment Co.
Pulmosan Safety Equipment Corp.
Safety First Supply Co.
Scott Aviation Corp.
Sellstrom Mfg. Co.
Southern Oxygen Co.
Willson Products Div.
Ray-O-Vac Co.

SAMPLERS—see Ore Samplers

SAND WASHING PLANTS
Acme Road Machinery Co.
Badinson Manufacturing Co., Inc.
Davis Foundry & Machine Works
Deister Machine Co.
Denver Equipment Co.
Diamond Iron Works Div.
Goodman Mfg. Co.
Dorr-Oliver, Inc.
Eagle Iron Works
Hardinge Co., Inc.
Iowa Mfg. Co.
Kennedy-Van Saun Mfg. & Eng. Corp.
Maddox Foundry & Machine Works, Inc.
McLanahan & Stone Corp.
Meckum Engineering, Inc.
Mine & Smelter Supply Co.
Marcy Mill Div.
Smith Engineering Works
Thomson-Starrett Co., Inc.
Roberts & Schaefer Co. Div.
Universal Engineering Corp.
Washington Machinery Co.
Western Machinery Co.

SAWS—see Tools
Atkins Saw Div.
Borg-Warner Corp.
Black & Decker Mfg. Co.
Blaw-Knox Co.
Chicago Pneumatic Tool Co.

Clipper Mfg. Co.
Curtis Manufacturing Co.
DeWalt, Inc.
Disston Div., Henry H. K. Porter Co., Inc. of Pittsburgh
General Steel Warehouse Co., Inc.
Gensco Tool Div.
Ingersoll-Rand Co.
Lancaster Pump & Mfg. Co.
Milwaukee Electric Tool Corp.
Peerless Machine Co.
Simonds Saw & Steel Co.
Stanley Electric Tools Div. Stanley Works
Syntron Co.
Thor Power Tool Co.
Titan Chain Saws, Inc.
Vulcan Iron Works Co. (Denver)

SAWS, CONCRETE & MASONRY
Clipper Mfg. Co.

SCALES, AUTOMATIC WEIGHING
Aerofall Mills, Inc.
Beaumont Birch Co.
Bell Aircraft Corp.
B-I-F Industries Builders-Providence Div.
Buffalo Scale Co., Inc.
Chatillon & Sons, John
Consolidated Packaging Machinery Corp.
Conveyor Co.
Fairbanks-Morse & Co.
Howe Scale Co., Inc.
Industrial Physics & Electronics Co.
Johnson Co., C. S.
Koehring Co.
McDowell Co. Dwight-Lloyd Div.
Merrick Scale Mfg. Co.
Omega Machine Co.
Revere Corp. of America
Richardson Scale Co.
Streeter-Amet Co.
Thurman Machine Co.
Toledo Scale Co.
Voland & Sons, Inc.
Webb Corp.

SCALES, PLATFORM
Bonded Scale & Machine Co.
Buffalo Scale Co., Inc.
Fairbanks-Morse & Co.
Howe Scale Co., Inc.
Industrial Physics & Electronics Co.
Johnson Co., C. S.
Revere Corp. of America
Streeter-Amet Co.
Thurman Machine Co.
Toledo Scale Co.
Webb Corp.
Williams & Green

SCALES, SACKING
Consolidated Packaging Machinery Corp.
Fairbanks-Morse & Co.
Industrial Physics & Electronics Co.
Richardson Scale Co.
Toledo Scale Co.
Torsion Balance Co.

SCALES, WEIGH HOPPER
Atlas Car & Mfg. Co.
Beaumont Birch Co.
Bodinson Manufacturing Co., Inc.
Buffalo Scale Co., Inc.
Chattanooga Boiler & Tank Co.
Columbus Conveyor Co.
Conveyor Co.
Erie Strayer Co.
Fairbanks-Morse & Co.
Holmes & Bros., Inc., Robert
Howe Scale Co., Inc.
Industrial Physics & Electronics Co.
Jeffrey Mfg. Co.
Johnson Co., C. S.
Kirk & Blum Mfg. Co.
Koehring Co.
Omega Machine Co.
Marathon Coal Bit Co.
Nolan Co.
Richardson Scale Co.
Streeter-Amet Co.
Thurman Machine Co.
Toledo Scale Co.
Washington Machinery Co.
Webb Corp.
Whiting Corp.
Williams & Green

SCINTILLATION COUNTERS—see Radiation Detectors

SCRAPERS, DRAGLINE—see Slusher Buckets or Slusher Hoists

Beaumont Birch Co.
Elmco Corp.
Joy Mfg. Co.
Landis Steel Co.
Manitoba Steel Foundries, Ltd.
Sauerman Bros., Inc.
Union Iron Works

SCRAPERS, WHEELED, SELF-PROPELLED & TOWED
Allis Chalmers Mfg. Co. Construction Machy. Div.
Allis Chalmers Mfg. Co. General Machinery Div.
American Tractor Equipment Corp.
Ateco Div. Greenville Steel Car Corp.
Be-Ge Mfg. Co.
Caterpillar Tractor Co.
Euclid Div. General Motors Corp.
Le Tourneau-Westinghouse Co.
Westinghouse Air Brake Co.
Wooldridge Mfg. Div. Continental Copper & Steel Industries Inc.

SCREEN CLOTH—see Wire Cloth

SCREEN ECCENTRICS & VIBRATORS —see also Vibrators
Bodinson Manufacturing Co., Inc.
Davis Foundry & Machine Works
Fairmont Machinery Co.
Hendrickson Mfg. Co.
Hewitt-Robins, Inc.
Holmes & Bros., Inc. Robert
Kanawha Mfg. Co.
Lecco Machinery & Engineering Co.
Link-Belt Co.
Nordberg Mfg. Co.
Prins & Associates, K.
Productive Equipment Corp.
Smith Engineering Works
Stephens-Adamson Mfg. Co.
Tyler Co., W. S.
Wilmot Engineering Co.

SCREEN HEATERS
Allis Chalmers Mfg. Co. General Machinery Div.
Deister Concentrator Co.
Deister Machine Co.
Hannon & Sons, F. R.
Lincoln Electric Co.
Link-Belt Co.
Screen Equipment Co., Inc.
Tyler Co., W. S.
Universal Vibrating Screen Co.

SCREEN PLATES & SHEET
American Brake Shoe Co.
American Brake Shoe Co. American Steel Div.
Card Iron Works, C. S.
Chicago Perforating Co.
Cross Engineering Co.
Diamond Mfg. Co.
Fairmont Machinery Co.
Flocker & Co., John
Harrington & King Perforating Co.
Hendrick Mfg. Co.
Kanawha Mfg. Co.
Laubenstein Mfg. Co.
Link-Belt Co.
Manganese Steel Forge Co.
McNally Pittsburg Mfg. Corp.
Phillips Corp.
Phoenix Iron & Steel Co.
Remaly Mfg. Co.
Savage Co., W. J.
Tema, N. Y.

SCREEN, WIRE & BAR
American Brake Shoe Co.
Bixby-Zimmer Engr. Co.
Buffalo Wire Works Co.
Cambridge Wire Cloth Co.
Chase Brass & Copper Co.
Cleveland Wire Cloth & Mfg. Co.
Colorado Fuel & Iron Corp.
Colorado Fuel & Iron Corp. Wickwire Spencer Steel Div.
Davis Foundry & Machine Works
Dorr-Oliver, Inc.
Hendrick Mfg. Co.
Hewitt-Robins, Inc.
Hoyt Wire Cloth Co.
Iowa Mfg. Co.
Korb-Pettit Wire Fabrics & Iron Works
Manganese Steel Forge Co.
McNally Pittsburg Mfg. Corp.
Newark Wire Cloth Co.
Patterson Foundry & Machine Co.
Phillips Corp.
Pioneer Engineering Works, Inc.
Simplicity Engineering Co.
Star Wire Screen & Iron Works
Tyler Co., W. S.
Universal Engineering Corp.
Wedge Bar Screen Corp.
Wedge Wire Corp.

SCREENS, CENTRIFUGAL
Flocker & Co., John
Hendrick Mfg. Co.
Link-Belt Co.
Nordberg Mfg. Co.
Tyler Co., W. S.

SCREENS, ELECTRICALLY HEATED
Allis Chalmers Mfg. Co. General Machinery Div.
Deister Concentrator Co.
Deister Machine Co.
Hewitt-Robins, Inc.
Link-Belt Co.
Overstrom & Sons, Inc.
Productive Equipment Corp.
Screen Equipment Co., Inc.
Simplicity Engineering Co.
Tyler Co., W. S.
Universal Vibrating Screen Co.

SCREENS, GRAVITY
Chicago Perforating Co.
Fairmont Machinery Co.
Flocker & Co., John
Hendrick Mfg. Co.
Hewitt-Robins, Inc.
Kanawha Mfg. Co.
Link-Belt Co.
Lippmann Engineering Works
Nolan Co.
Thompson-Starrett Co., Inc. Roberts & Schaefer Co. Div.
Tyler Co., W. S.

SCREENS, LIP
Flocker & Co., John
Hendrick Mfg. Co.
Link-Belt Co.
McNally Pittsburg Mfg. Corp.

SCREENS, REVOLVING
Acme Road Machinery Co.
Bartlett & Snow Co., C. O.
Bodinson Manufacturing Co., Inc.
Chicago Perforating Co.
Conveyor Co.
Davis Foundry & Machine Works
Denver Equipment Co.
Flocker & Co., John
Gruendler Crusher & Pulverizer Co.
Hendrick Mfg. Co.
Iowa Mfg. Co.
Laubenstein Mfg. Co.
Link-Belt Co.
Lippmann Engineering Works
Macklin Equipment Co.
Maddox Foundry & Machine Works, Inc.
McFarlane-Eggers Machinery Co.
McLanahan & Stone Corp.
Nordberg Mfg. Co.
Pioneer Engineering Works, Inc.
Remaly Mfg. Co.
Rogers Iron Works Co.
Savage Co., W. J.
Smith Engineering Works
Stephens-Adamson Mfg. Co.
Straub Mfg. Co.
Tyler Co., W. S.
Universal Road Machinery Co.
Washington Machinery Co.
Yuba Manufacturing Co.

SCREENS, SHAKING, VIBRATING & RECIPROCATING
Acme Road Machinery Co.
Aerofall Mills, Inc.
Allis Chalmers Mfg. Co. General Machinery Div.
Athey Products Corp.
Atlas Conveyor Co.
Barber-Greene Co.
Bodinson Manufacturing Co., Inc.
Bonded Scale & Machine Co.
Buffalo Wire Works Co.
Chattanooga Boiler & Tank Co.
Colorado Fuel & Iron Corp. Wickwire Spencer Steel Div.
Conveyor Co.
Davis Foundry & Machine Works
Deister Concentrator Co.
Deister Machine Co.
Denver Equipment Co.
Diamond Iron Works Div. Goodman Mfg. Co.
Dorr-Oliver, Inc.
Erolon Co.
Fahrenwald Co., A. W.
Fairmont Machinery Co.
Flocker & Co., John
Georgia Iron Works Co.
Gruendler Crusher & Pulverizer Co.
Hendrick Mfg. Co.
Hewitt-Robins, Inc.
Holmes & Bros., Inc., Robert
Iowa Mfg. Co.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Kennedy-Van Saun Mfg. & Eng. Corp.
Lecco Machinery & Engineering Co.
Link-Belt Co.
Lippmann Engineering Works
Maddox Foundry & Machine Works, Inc.
McFarlane-Eggers Machinery Co.
McLanahan & Stone Corp.
McNally Pittsburg Mfg. Corp.
National Iron Co.
Nordberg Mfg. Co.
Overstrom & Sons, Inc.
Patterson Foundry & Machine Co.
Pioneer Engineering Works, Inc.
Prins & Associates, K.
Productive Equipment Corp.
Remaly Mfg. Co.
Ridge Equipment Co.
Savage Co., W. J.
Screen Equipment Co., Inc.
Simplicity Engineering Co.
Smith Engineering Works
Southwestern Engineering Co.
Stearns Roger Mfg. Co.
Stephens-Adamson Mfg. Co.
Sturtevant Mill Co.
Syntron Co.
Tema, N. Y.
Tyler Co., W. S.
Universal Vibrating Screen Co.
Washington Machinery Co.
Williams Patent Crusher & Pulverizer Co.
Wilmot Engineering Co.

SCRUBBERS, ENGINE EXHAUST—see Exhaust, Scrubbers, Engine

SCRUBBERS & WASHERS, MINERAL
Acme Road Machinery Co.
Allis Chalmers Mfg. Co. General Machinery Div.
Bodinson Manufacturing Co., Inc.
Chattanooga Boiler & Tank Co.
Christian Engineers, J. D.
Conveyor Co.
Davis Foundry & Machine Works
Denver Equipment Co.
Diamond Iron Works Div. Goodman Mfg. Co.
Dorr-Oliver, Inc.
Eagle Iron Works
Filer & Stowell Co.
Georgia Iron Works Co.
Gruendler Crusher & Pulverizer Co.
Hardinge Co., Inc.
Iowa Mfg. Co.
Landis Steel Co.
Link-Belt Co.
Lippmann Engineering Works
Maddox Foundry & Machine Works, Inc.
McFarlane-Eggers Machinery Co.
McLanahan & Stone Corp.
Mine & Smelter Supply Co. Marcy Mill Div.
Pioneer Engineering Works, Inc.
Rogers Iron Works Co.
Smith Engineering Works
Stearns Roger Mfg. Co.
Universal Engineering Corp.
Universal Road Machinery Co.
Washington Machinery Co.
Western Machinery Co.
Yuba Manufacturing Co.

SEPARATORS & CONCENTRATORS —see specific item below; also see Classifiers

SEPARATORS, AIR— also see Classifiers, Air
Aerofall Mills, Inc.
Black Mfg. Co.
Centrifugal & Mech. Industries, Inc.
Combustion Engineering, Inc. Raymond Div.
Engineers Syndicate, Ltd.
Fuel Process Co.
Hardinge Co., Inc.
Houston Tool Co., Inc.
I-T-E Circuit Breaker Co.
Johnson Corp.
Kennedy-Van Saun Mfg. & Eng. Corp.
Leavitt Machine Co.
Logan Engineering Co.
Majac Inc.
Mechanical Industries, Inc.
New Jersey Meter Co.
Nicholson & Co., W. H.
Ogden Iron Works
Strong, Carlisle & Hammond Co.
Sturtevant Mill Co.
Sutton, Steele & Steele, Inc.
Thompson-Starrett Co., Inc. Roberts & Schaefer Co. Div.
U. S. Hoffman Corp. Air Appliance Div.
Universal Road Machinery Co.
Wilkerson Corp.
Williams Patent Crusher & Pulverizer Co.
Zurn Mfg. Co., J. A.

SEPARATORS, HEAVY MEDIA
Colorado Iron Works
Daniels Co. Contractors, Inc.
Davis Foundry & Machine Works
Dings Magnetic Separator Co.
Eagle Iron Works
Fairmont Machinery Co.
Hardinge Co., Inc.
Hewitt-Robins, Inc.
Jeffrey Mfg. Co.
Link-Belt Co.
Magnetic Engineering & Mfg. Co.
Majac Inc.
McNally Pittsburg Mfg. Corp.
Mine & Smelter Supply Co. Marcy Mill Div.

Ore & Chemical Corp.
Southwestern Engineering Co.
Stearns Magnetic, Inc.
Stearns Roger Mfg. Co.
Thompson-Starrett Co., Inc.
Roberts & Schaefer Co. Div.
Western Machinery Co.
Williams & Green
Wilmot Engineering Co.
Zurn Mfg. Co., J. A.

SEPARATORS, AMALGAMATING (Amalgamators)

Denver Equipment Co.
Mill & Mine Supply, Inc.
Mine & Smelter Supply Co.
Marcy Mill Div.
Morse Bros. Machinery Co.
Recoveries, Inc.
Snyder Mine & Chemical Lab.

SEPARATORS, ELECTROSTATIC

Carpco Manufacturing, Inc.
Ritter Products Corp.
Snyder Mine & Chemical Lab.
Zurn Mfg. Co., J. A.

SEPARATORS, JIG

Davis Foundry & Machine Works
Denver Equipment Co.
Dorr-Oliver, Inc.
Jeffrey Mfg. Co.
Link-Belt Co.
McLanahan & Stone Corp.
Meckum Engineering, Inc.
Morse Bros. Machinery Co.
Ottumwa Box Car Loader Co.
Prins & Associates, K.
Stearns Roger Mfg. Co.
Union Iron Works
Western Machinery Co.
Wilmot Engineering Co.
Yuba Manufacturing Co.
Zurn Mfg. Co., J. A.

SEPARATORS, MAGNETIC

Carboloy Dept.
General Electric Co.
Carpco Manufacturing, Inc.
Dings Magnetic Separator Co.
Electric Controller & Mfg. Co. Div.
Square D. Co.
Engineers Syndicate, Ltd.
Eriez Mfg. Co.
Exolon Co.
Frantz Co., Inc., S. G.
Homer Mfg. Co.
Indiana Commercial Filters Corp.
Jeffrey Mfg. Co.
Magnetic Engineering & Mfg. Co.
Recoveries, Inc.
Schrader Co., F. W.
Stearns Magnetic, Inc.
Stearns Roger Mfg. Co.
Thumes Mek. Vaerksted, A. S.
Western Machinery Co.
Zurn Mfg. Co., J. A.

SEPARATORS, SPIRAL

Denver Equipment Co.
Eagle Iron Works
Humphreys Investment Co. Engineering Div.
Smith Engineering Works
Western Machinery Co.
Zurn Mfg. Co., J. A.

SEPARATORS, TABLE

Deister Machine Co.
Denver Equipment Co.
Macklin Equipment Co.
Mine & Smelter Supply Co.
Marcy Mill Div.
Sutton, Steele & Steele, Inc.
Thompson-Starrett Co., Inc.
Roberts & Schaefer Co. Div.

SHAFT SINKING CONTRACTORS—also see Searchlight Section

Allen & Garcia Co.
Boyles Bros. Drilling Co., Inc.
Dravo Corp.
Johnson Co., R. G.
McKee & Co., Arthur G.
McKinney Drilling Co.
Tinney Drilling Co.
Utah Construction Co.
Winston Bros. Co.

SHEAVES—see Blocks; or Sheaves, Mine Hoist

SHEAVES, MINE HOIST

American Brake Shoe Co.
American Steel Div.
American Hoist & Derrick Co.
Bethlehem Pacific Coast Steel Corp.
Boyles Bros. Drilling Co., Inc. (Utah)
Card Iron Works, C. S.
Connellsville Mfg. & Mine Supply Co.
Farrell-Cheek Steel Co.
Hewitt-Robins, Inc.
Holmes & Bros., Inc., Robeert
Iowa Mfg. Co.
Jones Foundry & Machine Co., W. A.
Joy Mfg. Co.
Keeney Co., Paul E.
Ladish Co.
Lake Shore, Inc.
Lake Shore Engineering Div.
Maddox Foundry & Machine Works, Inc.
Madesco Tackle Block Co.
Medart Co.
National Iron Co.
Ogden Iron Works
Rogers Iron Works Co.
Sanford-Day Iron Works, Inc.
Sanford-Day Iron Works
Brown-Fayro Div.
Strah Process Steel Co.
Thompson-Starrett Co., Inc.
Roberts & Schaefer Co. Div.
Tool Steel Gear & Pinion Co.
Union Iron Works
Vulcan Iron Works
West Virginia Armature Co.
Wilmot Engineering Co.
Worthington Corp.

SIEVES, SHAKING—also see Screens

Bico, Inc.
Braun Corp.
Central Scientific Co.
Fahrenwald Co. A. W.
Newark Wire Cloth Co.
Thompson-Starrett Co., Inc.
Roberts & Schaefer Co. Div.
Tyler Co., W. S.
Universal Vibrating Screen Co.

SIEVES, TESTING

American Instrument Co., Inc.
Bico, Inc.
Braun Corp.
Commercial Testing & Engrg. Co.
Denver Equipment Co.
Dicke Tool Co.
Newark Wire Cloth Co.
Syntron Co.
Tyler Co., W. S.
Universal Vibrating Screen Co.

SIGNS & POSTERS

Brady Co., W. H.
Dicke Tool Co.
Elliott Service Co., Inc.
National Safety Council

SINTERING EQUIPMENT—also see Kilns; or Nodulizing Equipment

B-I-F Industries
Builders-Providence Div.
Carrier Conveyor Corp.
Dravo Corp.
Hewitt-Robins, Inc.
Heyl & Patterson, Inc.
Kennedy-Van Saun Mfg. & Eng. Corp.
Mace Co.
McDowell Co.
Dwight-Lloyd Div.
McFarlane-Eagers Machinery Co.
National Malleable & Steel Castings Co.
Omega Machine Co.
Simplicity Engineering Co.
Treadwell Co., M. H.

SKIPS & CAGES (MINE HOIST)

Atlas Car & Mfg. Co.
Bartlett & Snow Co., C. O.
Card Iron Works, C. S.
Connellsville Mfg. & Mine Supply Co.
Denver Equipment Co.
Helmick Foundry-Machine Co.
Hirsch Bros. Machy. Co.
Holmes & Bros., Inc., Robert
Lake Shore, Inc.
Lake Shore Engineering Div.
Mayo Tunnel & Mine Equipment Co.
Miners Foundry & Mfg. Co.
National Iron Co.
Nolan Co.
Nordberg Mfg. Co.
Ogden Iron Works
Rogers Iron Works Co.
Stearns Roger Mfg. Co.
Thompson-Starrett Co., Inc.
Roberts & Schaefer Co. Div.
Union Iron Works
Vulcan Iron Works Co. (Denver)

SLUSHER BUCKETS—see Buckets, Slusher-Scraper

SLUSHER HOISTS—also see Hoists; or Winches

Gardner-Denver Co.
Holman Bros. (Canada), Ltd.
Ingersoll-Rand Co.
Joy Mfg. Co.
Lidgerwood Industries, Inc.
Vulcan Iron Works Co. (Denver)

SPEED REDUCERS & INCREASERS—see Drives

American Pulley Co.
Barber-Greene Co.
Brad Foote Gear Works
Brad Foote Gear Works
Pittsburgh Gear Co. Div.
Brown, Inc., David
Chicago Pulley & Shafting Co.
Cleveland Worm & Gear Co.
Cone-Drive Gears Div.
Michigan Tool Co.
Dodge Mfg. Corp.
Dominion Engineering Co., Ltd.
Eberhardt Denver Co.
Subsidiary of Morse Chain Co.
Elliott Co.
Falk Corp.
Farrel-Birmingham Co., Inc.
Foote Bros. Gear & Machine Corp.
Hewitt-Robins, Inc.
Link-Belt Co.
Master Mfg. Co.
Metron Instrument Co.
National Iron Co.
Novo Pump & Engine Co.
Ohio Gear Co.
Perkins Machine & Gear Co.
Philadelphia Gear Works
Snow-Babstedt Gear Corp.
Stephens-Adamson Mfg. Co.
Sterling Electric Motors, Inc.
Twin Disc Clutch Co.
U. S. Electrical Motors, Inc.
Western Gear Corp.

SPROCKETS, CHAIN—see Chain Sprockets

STEEL—PLATES, SHAPES, ETC.—also see Buildings, Metal; Drill Steel; or Mine Supports, Metal

Alco Products, Inc.
American Brake Shoe Co.
American Steel Div.
Bethlehem Pacific Coast Steel Corp.
Bethlehem Steel Co., Inc.
Carpenter Steel Co.
Chattanooga Boiler & Tank Co.
Colorado Fuel & Iron Corp.
Colorado Fuel & Iron Corp.
Wickwire Spencer Steel Div.
Crucible Steel Co. of America
Dominion Steel & Coal Corp., Ltd.
Hapman Conveyors Inc.
Inland Steel Co.
Jones & Laughlin Steel Corp.
Lakeside Bridge & Steel Co.
Lukens Steel Co.
Mahon Co., R. C.
Ogden Iron Works
Phoenix Iron & Steel Co.
Remaly Mfg. Co.
Ryerson & Son, Inc., Joseph T.
Sheffield Steel Div.
Armco Steel Corp.
Sorel Steel Foundries, Ltd.
Tennessee Coal & Iron Div.
U. S. Steel Corp.
Union Carbide & Carbon Corp.
Electro Metallurgical Sls.
U. S. Steel Corp.
Columbia-Geneva Steel Div.
United States Steel Supply Co.
Wisconsin Bridge & Iron Co.
Wood Steel Co., Alan
Youngstown Sheet & Tube Co.

STEEL, ALLOY — PLATES, SHAPES, ETC.—also see Drill Steel or Mine Supports Metal

Alco Products, Inc.
Allegheny Ludlum Steel Corp.
American Brake Shoe Co.
American Brake Shoe Co.
American Steel Div.
Bethlehem Steel Co., Inc.
Carpenter Steel Co.
Chattanooga Boiler & Tank Co.
Colorado Fuel & Iron Corp.
Wickwire Spencer Steel Div.
Crucible Steel Co. of America
Dominion Engineering Co., Ltd.
Dominion Steel & Coal Corp., Ltd.
Graver Tank & Mfg. Co., Inc.
Hapman Conveyors, Inc.
Hoyland Steel Co.
Industrial Overlay Metals, Inc.
Jessop Steel Co.
Jones & Laughlin Steel Corp.
Lakeside Bridge & Steel Co.
Lukens Steel Co.
Manganese Steel Forge Co.
Midvale-Heppenstall
Northwest Steel Rolling Mills
Ryerson & Son, Inc., Joseph T.
Sheffield Steel Div.
Armco Steel Corp.
Stulz-Sickles Co.
Tennessee Coal & Iron Div.
U. S. Steel Corp.
U. S. Steel Corp.
Columbia-Geneva Steel Div.
United States Steel Supply Co.
Vanadium Corp. of America
Vanadium-Alloys Steel Co.
Youngstown Sheet & Tube Co.

STEEL MINE SUPPORTS & CIRCULAR SETS—see Mine Supports, Metal

STUD DRIVERS

Industrial Sales Div.
Remington Arms Co., Inc.

SURVEYING EQUIPMENT & SUPPLIES—also see Drafting Equipment & Supplies; Transits, Pocket

American Paulin System
Berger & Sons, C. L.
Black Diamond Spad Co.
Bruning Co., Inc., Charles
Brunson Instrument Co., Inc.
Buff & Buff Mfg. Co.
Copperweld Steel Co.
Dietzgen Co., Eugene
Elliott Co., B. K.
Geo-Optic Co., Inc.
Gurley, W. & L. E.
Kern Instruments, Inc.
Keuffel & Esser Co.
Leupold & Stevens Instruments, Inc.
Lufkin Rule Co.
Nucleonic Corp. of America
Rocky Mountain Instrument Co.
Sharp Instruments, Ltd.
Suverkrop Instruments
Universal Atomics Corp.
Warren-Knight Co.
White Co., David
Wild Heerbrugg Instruments, Inc.
Zeiss Aerotopograph

TANKS, LINED—also see Coatings or Linings

Allison Steel Mfg. Co.
American Hard Rubber Co.
American-Marsh Pumps, Inc.
Booth Co.
Butler Manufacturing Co.
Chattanooga Boiler & Tank Co.
Denver Equipment Co.
Galigher Co.
Gates Engrg. Co.
Goodall Rubber Co.
Goodrich Co., B. F.
Goodrich Industrial Products Co., B. F.
Goodyear Tire & Rubber Co.
Gramm Trailer Corp.
Graver Tank & Mfg. Co., Inc.
Hack Engineering Co.
Hall & Sons, Amos H.
Linatex Corp. of America
Luzerne Rubber Co.
Ogden Iron Works
Pollock Co., William B.
Porter Co., Inc., H. K.
Pioneer Rubber Div.
Porter Co., H. K.
Quaker Pioneer Rubber Div.
Process Engineering, Inc.
Universal Dredge Mfg. Co.
Willamette Iron & Steel Co.

TANKS, STEEL

Alco Products, Inc.
American-Marsh Pumps, Inc.
Armco Drainage & Metal Products, Inc.
Beall Pipe & Tank Corp.
Bethlehem Steel Co., Inc.
Bigelow Co.
Black Sivalls & Bryson, Inc.
Blaw-Knox Co.
Butler Manufacturing Co.
Chattanooga Boiler & Tank Co.
Chicago Bridge & Iron Co.
Columbian Steel Tank Co.
Davis Foundry & Machine Works
Denver Equipment Co.
Dominion Steel & Coal Corp., Ltd.
Duriron Co., Inc.
Erie City Iron Works
Gramm Trailer Corp.
Graver Tank & Mfg. Co., Inc.
Hapman Conveyors Inc.
Kanawha Mfg. Co.
Kirk & Blum Mfg. Co.
Lakeside Bridge & Steel Co.
Lukens Steel Co.
Maddox Foundry & Machine Works, Inc.
Mahon Co., R. C.
National Iron Co.
Ogden Iron Works
Oliver Corp.
A. B. Farquhar Div.
Ottumwa Box Car Loader Co.
Pacific Coast Engineering Co.
Patterson Foundry & Machine Co.
Phoenix Iron & Steel Co.
Pittsburgh-Des Moines Steel Co.
Posey Iron Works Inc.
Prins & Associates, K.
Process Engineering, Inc.
Schneible Co., Claude B.
Springfield Boiler Co.
Thompson-Starrett Co., Inc.
Roberts & Schaefer Co. Div.
Thumes Mek. Vaerksted, A. S.
Union Iron Works
Vulcan Iron Works
Westinghouse Air Brake Co.
Ind. Products Div.
Willamette Iron & Steel Co.
Williams & Green
Wilmot Engineering Co.
Wisconsin Bridge & Iron Co.

TANKS, WOOD
Acme Tank Mfg. Co.
Arrow Tank Co.
Atlantic Tank Corp.
Black, Sivalls & Bryson, Inc.
Caldwell Co., W. E.
Denver Equipment Co.
Federal Pipe & Tank Co.
Hall & Sons, Amos H.
Hauser-Stander Tank Co.
M & M Woodworking Co.
National Tank & Pipe Div.
Morse Bros. Machinery Co.
National Tank & Pipe Co.
Pacific Wood Tank Corp.
Santa Fe Tank & Tower Co.
Windeler Co., Ltd., George

TANKS, SPECIAL MATERIAL & OTHER
Neff & Fry Co.

TARPAULINS—see Cloth

TELEPHONES—see Communications

TELEVISION—see Communications

THERMOMETERS & THERMOCOUPLES—see Meters, Temperature

THICKENERS
Dagley Mfg. Co.
Denver Equipment Co.
Dorr-Oliver, Inc.
Eimco Corp.
Hardinge Co., Inc.
Hirsch Bros. Machy. Co.
Infilco, Inc.
Jeffrey Mfg. Co.
Kennedy-Van Saun Mfg. & Eng. Corp.
Link-Belt Co.
Mallinckrodt Chemical Works
Morse Bros. Machinery Co.
Peterson Filters & Engr. Co.
Prins & Associates, K.
Union Iron Works
Western Machinery Co.

TIMBER FRAMERS
Denver Equipment Co.
Filer & Stowell Co.
Stearns Roger Mfg. Co.

TIMBER PRESERVATIVES
American Lumber & Treating Co.
Barrett Div.
Allied Chemical & Dye Corp.
Baxter Co., J. H.
C A Wood Preserver Co.
Cabot, Inc., Samuel
Canadian Industries Ltd.
Carbolineum Wood Preserving Co.
Curtin-Howe Corp.
Darworth, Inc.
Cuprinol Div.
Dow Chemical Co.
DuPont de Nemours & Co., E. I.
Gilbreath Chemical Co.
Koppers Co., Inc.
Oronite Chemical Co.
Osmose Wood Preserving Co.
Reilly Tar & Chemical Corp.
Republic Creosoting Co.
Sherwin-Williams Co.
Tennessee Coal & Iron Div.
U. S. Steel Corp.
Tennessee Products & Chemical Corp.

TIRES & TUBES
Armstrong Rubber Co.
Firestone Tire & Rubber Co.
Gates Rubber Co.
General Tire & Rubber Co.
Gilmer Co., L. H.
Goodrich Co., B. F.
Truck & Bus Tire Dept.
Goodyear Tire & Rubber Co.
Goodyear Tire & Rubber Co.
Industrial Products
Phillips Petroleum Co.
Seiberling Rubber Co.
U. S. Rubber Co.
U. S. Royal Tire Division
Utah Oil Refining Co.

TOOLS, HAND
Ames Co., O.
Ampco Metal, Inc.
Beryllium Corp.
Bethlehem Pacific Coast Steel Corp.
Dicke Tool Co.
Disston Div., Henry
H. K. Porter Co., Inc. of Pittsburgh
Electric Materials Co.
General Steel Warehouse Co., Inc.
Gensco Tool Div.
Gibraltar Equipment & Mfg. Co.
Graybar Elec. Co., Inc.
Greene Tweed Co.
Ideal Industries, Inc.
Klein & Sons, Mathias
Leetonia Tool Co.
Lombard Governor Corp.
Lufkin Rule Co.
Owatonna Tool Co.
Salem Tool Co.
Snap-on-Tools Corp.
Toledo Pipe Threading Machine Co.
Willey's Carbide Tool Co.
Wood Shovel & Tool Co.
Worthington Corp.

TOOLS (HAND), POWER
Bethlehem Pacific Coast Steel Corp.
Black & Decker Mfg. Co.
Chicago Pneumatic Tool Co.
Cincinnati Electrical Tool Co.
DeWalt, Inc.
Gardner-Denver Co.
Gibraltar Equipment & Mfg. Co.
Graybar Elec. Co., Inc.
Holman Bros. (Canada), Ltd.
Homelite Corp.
Ingersoll-Rand Co.
Lombard Governor Corp.
Milwaukee Electric Tool Corp.
Porter-Cable Machine Co.
Reed Roller Bit Co.
Snap-on-Tools Corp.
Stanley Electric Tools Div.
Stanley Works
Syntron Co.
Thor Power Tool Co.
Toledo Pipe Threading Machine Co.
U. S. Electrical Tool Co.
Willey's Carbide Tool Co.
Wodack Electric Tool Corp.
Worthington Corp.
Wright Power Saw & Tool Corp.

TORQUE CONVERTERS—see Drives

TRACK—see Rail & Track

TRACK CLEANING MACHINES
American Mine Door Co.
Athey Products Corp.
Nordberg Mfg. Co.

TRACK GAGE-RODS & LEVELS
Aldon Co.
Bethlehem Pacific Coast Steel Corp.
Central Frog & Switch Co.
Foster Co., L. B.
Gibraltar Equipment & Mfg. Co.
Howells Mining Drill Co.
Nordberg Mfg. Co.
Oliver Iron & Steel Corp.
West Virginia Steel & Mfg. Co.

TRACK SWITCH THROWERS
American Brake Shoe Co.
American Mine Door Co.
Bethlehem Pacific Coast Steel Corp.
Bethlehem Steel Co., Inc.
Card Iron Works, C. S.
Central Frog & Switch Co.
Cheatham Electric Switching Device Co.
Foster Co., L. B.
Pettibone Mulliken Corp.
Westinghouse Air Brake Co.

TRACTOR ATTACHMENTS—also see Bulldozer & Grader Blades or Loaders
Allis Chalmers Mfg. Co.
Construction Machy. Div.
Baker Mfg. Co. Div.
Allis-Chalmers Mfg. Co.
Balderson, Inc.
Caterpillar Tractor Co.
Drott Mfg. Co.
Easton Car & Construction Co.
Eimco Corp.
Gar Wood Industries, Inc.
Hales Co., W. M.
Hendrickson Mfg. Co.
Hyster Co.
International Harvester Export Co.
Le Tourneau-Westinghouse Co.
Oliver Corp.
Sheppard Co., Inc., R. H.
Tractomotive Corp.
Westinghouse Air Brake Co.
Le Roi Div.

TRACTOR WEAR-REPLACEMENT PARTS

TRACTORS, CRAWLER
Allis Chalmers Mfg. Co.
Construction Machy. Div.
Allis Chalmers Mfg. Co.
General Machinery Div.
Baker Mfg. Co. Div.
Allis-Chalmers Mfg. Co.
Caterpillar Tractor Co.
Craig Carroll Co.
Diesel Energy Corp.
Drott Mfg. Co.
Eimco Corp.
Euclid Div.
General Motors Corp.
International Harvester Export Co.
Oliver Corp.

TRACTOR, WHEELER—also see Truck Tractors
Allis-Chalmers Mfg. Co.
Buda Div.
Allis Chalmers Mfg. Co.
Construction Machy. Div.
Allis Chalmers Mfg. Co.
General Machinery Div.
Baker-Lull Corp.
Case Co., J. I.
Industrial Div.
Caterpillar Tractor Co.
Diesel Energy Corp.
Drott Mfg. Co.
Hough Co., Frank G.
International Harvester Export Co.
Kersey Mfg. Co., Inc.
Le Tourneau-Westinghouse Co.
Oliver Corp.
Pettibone Mulliken Corp.
Sheppard Co., Inc., R. H.
Walter Motor Truck Co.
Westinghouse Air Brake Co.

TRAMP IRON DETECTORS
Industrial Physics & Electronics Co.
Radiac Co., Inc.
Stearns Magnetic, Inc.

TRANSFORMERS
Allis Chalmers Mfg. Co.
General Machinery Div.
Burton Equipment Co., Inc.
Eisler Engineering Co.
Federal Electric Co.
Pacific Electric Switchgear Div.
Gardner Electric Mfg. Co.
General Electric Co.
Apparatus Sales Div.
General Nuclear Corp.
Graybar Elec. Co., Inc.
Hevi-Duty Electric Co.
I-T-E Circuit Breaker Co.
International General Electric Co.
Knopp, Inc.
Kolton Electric Mfg. Co.
Kuhlman Electric Co.
Line Material Co.
Lectromelt Furnace Co. Div.
McGraw Electric Co.
Moloney Electric Co.
Pennsylvania Transformer Co.
Perkins Engineering Co.
Sorgel Electric Co.
Standard Transformer Co.
Universal Welder Corp.
Wagner Electric Corp.
Westinghouse Electric Corp.

TRANSITS, POCKET
Ainsworth & Sons, William
Dietzgen Co., Eugene
Elliott Co., B. K.
Geo-Optic Co., Inc.
Gurley, W. & L. E.
Keuffel & Esser Co.
White Co., David
Wild Heerbrugg Instruments, Inc.

TRANSMISSIONS, VARIABLE SPEED —see Drives

TRAPS, AIR & STEAM, PIPE
Crane Co.
Drullard Co., Howard
Leavitt Machine Co.
New Jersey Meter Co.
Nicholson & Co., W. H.
Ogden Iron Works
Sarco Co., Inc.
Strong, Carlisle & Hammond Co.
Yarnall-Waring Co.

TROLLEY (ELECTRICAL HAULAGE) ACCESSORIES
Deltron Electric Products, Inc.
Elreco Corp.
Flood City Brass & Elec. Co.
Forker Corp.
Malleable Iron Fittings Co.
Mining Machine Parts, Inc.
Ohio Brass Co.
West Virginia Armature Co.

TRUCK (& TRACTOR) TRAILERS & WAGONS
Arrow Mfg. Co.
Butler Manufacturing Co.
C & D Div.
Yuba Manufacturing Co.
Cline Truck Co.
Dorsey Trailers
Easton Car & Construction Co.
Enterprise Wheel & Car Corp.
Fruehauf Trailer Co.
Gramm Trailer Corp.
Heil Co.
LaCrosse Trailer Corp.
McCabe-Powers Auto Body Co.
Oshkosh Motor Truck, Inc.
Rogers Brothers Corp.
Salem-Brosius, Inc.
Transport Trailers, Inc.
Truck Engineering Corp.
Winter-Weiss Co.

TRUCK & TRAILER BODIES
Anthony Co.
Baughman Manufacturing Co., Inc.
Easton Car & Construction Co.
Enterprise Wheel & Car Corp.
Galion Allsteel Body Co.
Gar Wood Industries, Inc.
Heil Co.
Hercules Steel Product Corp.
Hockensmith Corp.
Marion Metal Products Co.
Maxon Construction Co.
Oshkosh Motor Truck, Inc.
Schonrock Equipment Mfg. Co.
Transport Trailers, Inc.
Truck Engineering Corp.

TRUCKS & TRUCK TRACTORS—also see Shuttle Cars
Chrysler Corp.
Dodge Truck Div.
Cline Truck Co.
Dart Truck Co.
Euclid Div.
General Motors Corp.
Federal Motor Truck Co.
Ford Motor Co.
Fourwheel Drive Auto Co.
Getman Brothers
International Harvester Export Co.
International Harvester Co.
Motor Truck Div.
Kenworth Motor Truck Corp.
Klockner-Humboldt-Deutz Ag.
c/o Diesel Energy Corp.
Koehring Co.
Lamson Corp.
Mack Trucks, Inc.
Marmon-Harrington Co.
Napco Industries, Inc.
Oshkosh Motor Truck, Inc.
Reo Motors, Inc.
Walter Motor Truck Co.
White Motor Co.
Willys Motors, Inc.

TRUCKS, LIFT, FORK & PLATFORM (INDUSTRIAL)
American Pulley Co.
Silent Hoist & Crane Corp.

TUBING, METAL—also see Pipe
Allegheny Ludlum Steel Corp.
Aluminum Co. of America
Ampco Metal, Inc.
Carpenter Steel Co.
Chase Brass & Copper Co.
Crucible Steel Co. of America
International Nickel Co.
Phelps Dodge Copper Products Corp.
Revere Copper & Brass, Inc.
Reynolds Metals Co.
Ryerson & Son, Inc., Joseph T.
Swepco Tube Corp.
Triangle Conduit & Cable Co.
U. S. Steel Corp.
Columbia-Geneva Steel Div.
U. S. Steel Corp.
National Tube Div.
United States Steel Supply Co.
Wolverine Tube Div.
Calumet & Hecla, Inc.
Youngstown Sheet & Tube Co.

TURBINES, STEAM, HYDRAULIC, GAS, ETC.—also see Engines
Allis Chalmers Mfg. Co.
General Machinery Div.
Clark Brothers Co., Div.
Dresser Operations, Inc.
Coppus Engineering Co.
Davis Foundry & Machine Works
Dean Hill Pump Co.
DeLaval Steam Turbine Co.
Dominion Engineering Co., Ltd.
Elliott Co.
General Electric Co.
Apparatus Sales Div.
General Electric Co.
Ind. Haulage Div.—Loco. & Car Equip. Divs.
International General Electric Co.
Leffel & Co., James
Murray Iron Works Co.
Pyle-National Co.
Terry Steam Turbine Co.
Wing Mfg. Co., L. J.
Worthington Corp.

ULTRAVIOLET LIGHTS
Atomic Research Corp.
Braun Corp.
Colorado Assaying Co.
Detectron Corp.
Geophysical Instrument & Supply Co.
International General Electric Co.
Jarrell-Ash Co.
Macbeth Daylighting Corp.
Menlo Research Laboratory
Radiac Co., Inc.
Sylvania Electric Products, Inc.
Ultra-Violet Products, Inc.
Universal Atomics Corp.
Western Radiation Laboratory

UNLOADERS, CAR & TRUCK
Barber-Greene Co.
Bonded Scale & Machine Co.
Clyde Iron Works, Inc.

Conreader Co., R.
Dravo Corp.
General American Transportation Corp.
Hough Co., Frank G.
Jeffrey Mfg. Co.
Link-Belt Co.
Lippmann Engineering Works
McKiernan-Terry Corp.
Ottumwa Box Car Loader Co.
Simplicity Engineering Co.
Specialty Engineering Co.

USED EQUIPMENT—see E&MJ Searchlight Section
Acme Road Machinery Co.
Denver Equipment Co.
Drullard Co., Howard
Kenyon Walker Machinery Co.
Machinery Center, Inc.
Minerals Engineering Co.
Morse Bros. Machinery Co.
National Mine Service Co.
Simplicity Engineering Co.
Washington Machinery Co.
Whites Electronics

VALVES
ACF Industries, Inc.
Allen-Sherman-Hoff Pump Co.
American Chain & Cable Co., Inc. R-P&C Valve Div.
Automatic Switch Co.
B-I-F Industries Builders-Providence Div.
Barrett Haentjens & Co.
Be-Ge Mfg. Co.
Black, Sivalls & Bryson, Inc.
Blaw-Knox Co.
Bristol Co.
Cash Co., A. W.
Catawissa Valve & Fittings Co.
Conrader Co., R.
Crane Co.
Crosby Steam Gage & Valve Co.
Darling Valve & Mfg. Co.
Diamond Power Specialty Corp.
Dixon Valve & Coupling Co.
Dominion Engineering Co., Ltd.
Duriron Co., Inc.
Edward Valves, Inc.
Electric Steel Foundry Co.
Equipment Engineers
Everlasting Valve Co.
Fairbanks Co.
Farris Flexible Valve Corp.
Filer & Stowell Co.
Fisher & Porter Co.
Foxboro Co.
Galland Henning Mfg. Co.
Golden-Anderson Valve Specialty Co.
Goyne Steam Pump Co.
Grinnell Co., Inc.
Guyan Machy. Co.
Hamer Valves, Inc.
Hills-McCanna Co.
Homestead Valve Mfg. Co.
Hose Accessories Co.
Hunt & Son, Inc., C. B.
Jacuzzi Bros., Inc.
Jenkins Bros.
Kennedy Valve Mfg. Co.
Kieley & Mueller, Inc.
Klipfel Valves, Inc.
Knox Mfg. Co.
LaBour Co.
Ledeen Mfg. Co.
Linatex Corp. of America
Lonergan Co., J. E.
Lunkenheimer Co.
Luzerne Rubber Co.
MacClatchie Mfg. Co.
Mahr Mfg. Co.
McDonald Mfg. Co., A. Y.
McNally Pittsburg Mfg. Corp.
Merco Nordstrom Valve Co.
Mine & Smelter Supply Co. Marcy Mill Div.
Minneapolis-Honeywell Regulator Co.
Minneapolis-Honeywell Regulator Co. Industrial Div.
Nathan Mfg. Co.
National Lead Co.
New York Air Brake Co.
New York Air Brake Co. Hydraulic Div.
Nicholson & Co., W. H.
Okadee Co.
Ohio Brass Co.
Ohio Injector Co.
Penberthy Injector Co.
Pennsylvania Pump & Compressor Co.
Philadelphia Gear Works
Powell Co., Wm.
Red Jacket Company, Inc.
Republic Flow Meters Co.
Rockwell Mfg. Co.
Sarco Co., Inc.
Schutte & Koerting Co.
Stockham Valves & Fittings
Strong, Carlisle & Hammond Co.
Vogt Machine Co., Henry
Walworth Co.
Westinghouse Air Brake Co. Ind. Products Div.
Weston Electrical Instrument Corp. Subsidiary of Daystrom, Inc.
Willamette Iron & Steel Co.
Zurn Mfg. Co., J. A.

VALVE OPERATING MECHANISMS —also see Controls
Automatic Switch Co.
B-I-F Industries Builders-Providence Div.
Bristol Co.
Crane Co.
Fisher & Porter Co.
Homestead Valve Mfg. Co.
Klipfel Valves, Inc.
Ledeen Mfg. Co.
Leeds & Northrup Co.
Merco Nordstrom Valve Co.
Minneapolis-Honeywell Regulator Co.
Minneapolis-Honeywell Regulator Co. Industrial Div.
Okadee Co.
Philadelphia Gear Works
Republic Flow Meters Co.

VENTILATION PIPE & TUBING
American Brattice Cloth Corp.
Chattanooga Boiler & Tank Co.
Drullard Co., Howard
DuPont de Nemours & Co., Inc., E. I. Fabrics Div.
DuPont de Nemours & Co., Inc., E. I. Ventube Div.
Flexaust Co.
Flexible Tubing Co.
Johns-Manville
Kirk & Blum Mfg. Co.
National Motor Bearings Arrowhead Rubber Co. Div.
Naylor Pipe Co.
Sutphen, Peter O.

VIBRATORS & VIBRATING DEVICES —also see Car Shakers; Screen Eccentrics
Bonded Scale & Machine Co.
Branford Co.
Chicago Pneumatic Tool Co.
Cleveland Vibrator Co.
Eriez Mfg. Co.
Hewitt-Robins, Inc.
Ingersoll-Rand Co.
Jeffrey Mfg. Co.
Martin Engineering Co.
McNally Pittsburg Mfg. Corp.
Syntron Co.
Tema, N. V.
Thor Power Tool Co.
Tyler Co., W. S.

VOLTAGE REGULATORS
Allis Chalmers Mfg. Co. General Machinery Div.
Braun Corp.
Clark Controller Co.
Curtiss-Wright Corp. Electronics Div.
General Electric Co. Apparatus Sales Div.
General Electric Co. Ind. Haulage Div.—Loco. & Car Equip. Divs.
General Nuclear Corp.
Graybar Elec. Co., Inc.
International General Electric Co.
Leeds & Northrup Co.
Line Material Co.
Westinghouse Electric Corp.
Weston Electrical Instrument Corp. Subsidiary of Daystrom, Inc.

WATER CLARIFICATION & TREATMENT EQUIPMENT
Allis Chalmers Mfg. Co. General Machinery Div.
American Water Softener Co.
American Well Works
B-I-F Industries Builders-Providence Div.
Bird Machine Co.
Carter Co., Ralph B.
Chain Belt Co.
Connellsville Mfg. & Mine Supply Co.
Daniels Co. Contractors, Inc.
Dorr-Oliver, Inc.
Dow Chemical Co.
Elmco Corp.
Fisher & Porter Co.
Hardinge Co., Inc.
Heyl & Patterson, Inc.
Houdaille Industries, Inc. Manzel Div.
Infilco, Inc.
Ionics, Inc.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Link-Belt Co.
Omega Machine Co.
Penberthy Injector Co.
Permutit Co.
Peterson Filters & Engr. Co.
Prins & Associates, K.
Savage Co., W. J.
Thompson-Starrett Co., Inc.
Roberts & Schaefer Co. Div
Water Neutralizing Co.
Western Machinery Co.

WATER CLARIFICATION & TREATMENT CHEMICALS
Allis Chalmers Mfg. Co. General Machinery Div.
American Cyanamid Co. Mineral Dressing Dept.
American Sand-Banum Co., Inc.
American Water Softener Co.
Atlas Powder Co.
Calgon, Inc.
Canadian Industries Ltd.
DuPont de Nemours & Co., E. I.
Food Machinery & Chemical Corp. Westvaco Mineral Products Div. Westvaco Chlor-Alkali Div.
General Chemical Div. Allied Chemical & Dye Corp.
Mallinckrodt Chemical Works
Permutit Co.
Philadelphia Quartz Co.
Solvay Process Div. Allied Chemical & Dye Corp.
Stein, Hall & Co., Inc.
Van Waters & Rogers, Inc.

WEIGH HOPPERS—see Scales, Weigh Hopper

WELDING EQUIPMENT—also see Metallizing
Air Reduction Co., Inc.
American Brake Shoe Co.
American Brake Shoe Co. American Steel Div.
American Optical Co.
Eisler Engineering Co.
Flexo Products, Inc.
General Electric Co. Apparatus Sales Div.
Guyan Machy. Co.
Harnischfeger Corp. P & H Diesel Div.
Hobart Bros. Co.
Indiana Oxygen Co.
Industrial Air Products Co.
International General Electric Co.
Kaiser Aluminum & Chemical Sales, Inc.
Lincoln Electric Co.
Marathon Coal Bit Co.
Marquette Mfg. Co., Inc.
Metal & Thermite Corp.
Miller Electric Mfg. Co., Inc.
National Cylinder Gas Co.
Ohio Brass Co.
Rodriguez & Gillespie Co.
Sight Feed Generator Co.
Smith Welding Equipment Corp.
Southern Oxygen Co.
Tweco Products, Inc.
Union Carbide & Carbon Corp. Linde Air Products Co. Div.
U. S. Steel Corp. Columbia-Geneva Steel Div.
Universal Welder Corp.
Victor Equipment Co.
Wall Colmonoy Corp.
Westinghouse Electric Corp.
Worthington Corp.

WELDING RODS, ELECTRODES, SOLDER, ETC.—also see Hard-facing
Air Reduction Co., Inc.
Alloy Rods Co.
All-State Welding Alloys Co., Inc.
American Brake Shoe Co.
American Brake Shoe Co. American Steel Div.
Ampco Metal, Inc.
Arcos Corp.
Crucible Steel Co. of America
Eisler Engineering Co.
Eutectic Welding Alloys Corp.
General Electric Co. Apparatus Sales Div.
Handy & Harman
Harnischfeger Corp. P & H Diesel Div.
Hobart Bros. Co.
International General Electric Co.
International Nickel Co.
Lincoln Electric Co.
Marathon Coal Bit Co.
Marquette Mfg. Co., Inc.
McKay Co.
Metal & Thermite Corp.
Miller Electric Mfg. Co., Inc.
National Cylinder Gas Co.
Pure Carbon Co.
Revere Copper & Brass, Inc.
Shwayder Chemical Metallurgy Corp.
Sight Feed Generator Co.
Southern Oxygen Co.
Stulz-Sickles Co.
Superior Carbon Products, Inc.
Titan Metal Mfg. Co.
Union Carbide & Carbon Corp. Haynes Stellite Co. Div.
Union Carbide & Carbon Corp. Linde Air Products Co. Div.
United States Steel Supply Co.
Universal Welder Corp.
Victor Equipment Co.
Westinghouse Electric Corp.

WHEELS—see Car (& Locomotive) Wheels

WINCHES—see specific type below; also see Hoists
Allis Chalmers Mfg. Co. Construction Machy. Div.
American Engineering Co.
Bodinson Manufacturing Co., Inc.
Chicago Pneumatic Tool Co.
Clyde Iron Works, Inc.
Fourwheel Drive Auto Co.
Gar Wood Industries Inc.
Hewitt-Robins, Inc.
Indiana Foundry Co.
Joy Mfg. Co.
Ledeen Mfg. Co.
Lidgerwood Industries, Inc.
Link-Belt Co.
Northwestern Electric Co.
O. K. Machinery Div. John C. Motter Printing Press Co.
Ohio Hoist & Mfg. Co., Inc.
Robbins & Myers, Inc.
Round & Son, Inc., David
Sauerman Bros., Inc.
Silent Hoist & Crane Corp.
Stephens-Adamson Mfg. Co.
Stimmel Winch Co., Inc.
Superior-Lidgerwood-Mundy Corp.
Truck Engineering Corp.
Western Gear Corp.
Willamette Iron & Steel Co.
Yuba Manufacturing Co.

WINCHES, AIR & HYDRAULIC
American Engineering Co.
Atlas Copco Eastern, Inc.
Chicago Pneumatic Tool Co.
Holman Bros. (Canada), Ltd.
Joy Mfg. Co.
Ledeen Mfg. Co.
Lidgerwood Industries, Inc.
Northwestern Electric Co.
Stimmel Winch Co., Inc.
Superior-Lidgerwood-Mundy Corp.
Vickers, Inc.
Western Gear Corp.
Yuba Manufacturing Co.

WINCHES, DIESEL & GASOLINE
American Engineering Co.
Chicago Pneumatic Tool Co.
Clyde Iron Works, Inc.
Hyster Co.
Joy Mfg. Co.
Lidgerwood Industries, Inc.
Northwestern Electric Co.
O. K. Machinery Div. John C. Motter Printing Press Co.
Ohio Hoist & Mfg. Co., Inc.
Silent Hoist & Crane Corp.
Stimmel Winch Co., Inc.
Superior-Lidgerwood-Mundy Corp.
Vulcan Iron Works Co. (Denver)
Western Gear Corp.

WINCHES, ELECTRIC
American Engineering Co.
Atlas Corp.
Bodinson Manufacturing Co., Inc.
Christian Engineers, J. D.
Clyde Iron Works, Inc.
Electro Lift, Inc.
Harnischfeger Corp. P & H Diesel Div.
Hewitt-Robins, Inc.
Holmes & Bros., Inc., Robert
Jeffrey Mfg. Co.
Joy Mfg. Co.
Lidgerwood Industries, Inc.
Link-Belt Co.
Magnus, Inc., W. R.
Northwestern Electric Co.
O. K. Machinery Div. John C. Motter Printing Press Co.
Ohio Hoist & Mfg. Co., Inc.
Robbins & Myers, Inc.
Round & Son, Inc., David
Sauerman Bros., Inc.
Shepard Niles Crane & Hoist Corp.
Silent Hoist & Crane Corp.
Stearns Roger Mfg. Co.
Stephens-Adamson Mfg. Co.
Stimmel Winch Co., Inc.
Superior-Lidgerwood-Mundy Corp.
Vulcan Iron Works Co. (Denver)
Western Gear Corp.

WINCHES, HAND
American Engineering Co.
Bartlett & Snow Co., C. O.
Bodinson Manufacturing Co., Inc.
Channon Corp., J. H.
Fairmont Machinery Co.
Indiana Foundry Co.
Link-Belt Co.
Lug-All Co.
Ohio Hoist & Mfg. Co., Inc.
Round & Son, Inc., David

Stephens-Adamson Mfg. Co.
Stimmel Winch Co., Inc.
Thompson-Starrett Co., Inc.
Roberts & Schaefer Co. Div.
Western Gear Corp.

WIRE CLOTH

Buffalo Wire Works Co.
Cambridge Wire Cloth Co.
Chase Brass & Copper Co.
Cleveland Wire Cloth & Mfg. Co.
Colorado Fuel & Iron Corp.
Colorado Fuel & Iron Corp.
Wickwire Spencer Steel Div.
Davis Foundry & Machine Works
Flocker & Co., John
Hewitt-Robins, Inc.
Hoyt Wire Cloth Co.
Iowa Mfg. Co.
Ludlow-Saylor Wire Cloth Co.
Manganese Steel Forge Co.
Newark Wire Cloth Co.
Overstrom & Sons, Inc.
Patterson Foundry & Machine Co.
Pioneer Engineering Works, Inc.
Plummer Mfg. Co., W. A.
Simplicity Engineering Co.
Tyler Co., W. S.

WIRE ROPE

American Chain & Cable
American Chain & Cable Co.
American Cable Div.
American Chain & Cable Co.
Hazard Wire Rope Div.
Bergen Wire Rope
Bethlehem Pacific Coast Steel Corp.
Bethlehem Steel Co., Inc.
Broderick & Bascom Rope Co.
Colorado Fuel & Iron Corp.
Colorado Fuel & Iron Corp.
John A. Roebling's Sons Co. Div.
Colorado Fuel & Iron Corp.
Wickwire Spencer Steel Div.
Edwards Wire Rope
Hales Co., W. M.
Jones & Laughlin Steel Corp.
Leschen Wire Rope Div.
H. K. Porter Co., Inc.
Macwhyte Co.
McMillan's Sons, W. H.
National Mine Service Co.
Pacific Wire Rope Co.
Paulsen-Webber Cordage Corp.
Phillips Corp.
Riblet Tramway Co.
Rochester Ropes, Inc.
Ryerson & Son, Inc., Joseph T.
Sauerman Bros., Inc.
Sunbury Wire Rope Mfg. Co.
Tennessee Coal & Iron Div.
U. S. Steel Corp.
Union Wire Rope Corp.
Upson-Walton Co.
U.S. Steel Corp.
American Steel & Wire Div.
U. S. Steel Corp.
Columbia-Geneva Steel Div.
Westinghouse Air Brake Co.
Wire Rope Corp. of America, Inc.
Yara Engineering Corp.
Interstate Equipment Div.

WIRE ROPE DRESSING—see Lubricants

WIRE ROPE FITTINGS

American Chain & Cable
American Chain & Cable Co.
American Cable Div.
American Chain & Cable Co.
Hazard Wire Rope Div.
Bethlehem Steel Co. Inc.
Broderick & Bascom Rope Co.
Colorado Fuel & Iron Corp.
Colorado Fuel & Iron Corp.
John A. Roebling's Sons Co. Div.
Colorado Fuel & Iron Corp.
Wickwire Spencer Steel Div.
Electric Steel Foundry Co.
Electroline Co.
Farrell-Cheek Steel Co.
Hayes Steel Products, Ltd.
Jones & Laughlin Steel Corp.
Kellems Co.
Lamson & Sessions Co.
Laughlin Co., Inc.
American Hoist & Derrick Co.
Leschen Wire Rope Div.
H. K. Porter Co., Inc.
Macwhyte Co.
McMillan's Sons, W. H.
National Production Co.
Oliver Iron & Steel Corp.
Pacific Wire Rope Co.
Paulsen-Webber Cordage Corp.
Riblet Tramway Co.
Sauerman Bros., Inc.
Sunbury Wire Rope Mfg. Co.
Tennessee Coal & Iron Div.
U. S. Steel Corp.
Union Wire Rope Corp.
Upson-Walton Co.
Yara Engineering Corp.
Interstate Equipment Div.

WIRE ROPE SLINGS

American Chain & Cable
American Chain & Cable Co.
Hazard Wire Rope Div.
Bethlehem Pacific Coast Steel Corp.
Bethlehem Steel Co., Inc.
Broderick & Bascom Rope Co.
Cambridge Wire Cloth Co.
Colorado Fuel & Iron Corp.
Colorado Fuel & Iron Co.
John A. Roebling's Sons Co. Div.
Colorado Fuel & Iron Corp.
Wickwire Spencer Steel Div.
Electric Steel Foundry Co.
Jones & Laughlin Steel Corp.
Leschen Wire Rope Div.
H. K. Porter Co., Inc.
Macwhyte Co.
McMillan's Sons, W. H.
New Jersey Zinc Co.
Pacific Wire Rope Co.
Paulsen-Webber Cordage Corp.
Rochester Ropes, Inc.
Ryerson & Son, Inc., Joseph T.
Sunbury Wire Rope Mfg. Co.
Tennessee Coal & Iron Div.
U. S. Steel Corp.
Union Wire Rope Corp.
U. S. Steel Corp.
Columbia-Geneva Steel Div.
Upson-Walton Co.
Wire Rope Corp. of America, Inc.

WIRE SCREEN—see Screen, Wire & Bar

SECTION 2: COMPANY ADDRESSES

A

Abrams Aerial Survey Corp.
606 Shiawassee St.
Lansing Mich.

ACF Industries, Inc.
30 Church St.
New York 7, N. Y.

Acker Drill Co.
725 West Lackawanna Ave.
Scranton 3, Pa.

Ackerman-Johnson Co.
625 Jackson Blvd.
Chicago 6, Ill.

Acme Electric Heating Co.
1217 Washington St.
Boston 18, Mass.

Acme Fishing Tool Co. Div.
Stardrill-Keystone Co.
Parkersburg W. Va.

Acme Machinery Co.
P. O. Box 1169
Williamson, W. Va.

Acme Road Machinery Co.
E. Main St.
Frankfort, N. Y.

Acme Tank Mfg. Co.
12,000 E. Washington
Whittier, Calif.

Adames Carbide Co.
121 Market St.
Kenelworth, N. J.

Advance Car Mover Co., Inc.
Box 536
Appleton, Wis.

Aero Service Corp.
210 East Courtland St.
Philadelphia 20, Pa., page 166

Aero Service Corp. (Mid-Continent)
1401 South Detroit St.
Tulsa, Okla.

Aero Service Corp. (Western)
500 Christie Bldg.
Duluth, Minn.

Aero Service Corp. (Western)
33 Richards St.
Salt Lake City 10, Utah

Aerofall Mills, Inc.
1025 W. Third Ave.
Columbus 8, Ohio

Aeroquip Corp.
300 South East Ave.
Jackson, Mich.

Aetna Ball & Roller Bearing Co. Div.
Parkersburg-Aetna Corp.
4600 Schubert Ave.
Chicago 39, Ill.

African Surveys (Pty.), Ltd.
44 Nugget St.
Johannesburg, Union of South Africa

Ahlberg Bearing Co.
3025 W. 47th St.
Chicago 32, Ill.

Ainsworth & Sons William
2151 Lawrence St.
Denver 2, Colo., page 222

Air Reduction Co., Inc.
150 East 42nd St.
New York 17, N. Y.

Ajax Flexible Coupling Co.
Westfield, N. Y.

Albany Felt Co.
Albany 1, N. Y.

Alco Products, Inc.
Schenectady 5, N. Y.

Aldon Co.
3338 Ravenswood Ave.
Chicago, Ill.

Aldrich Pump Co.
1 Pine St.
Allentown, Pa.

Allegheny Ludlum Steel Corp.
2020 Oliver Bldg.
Pittsburgh 22, Pa.

Allen & Garcia Co.
332 South Michigan Ave.
Chicago 4, Ill.

Allen-Bradley Co.
1305 S. 1st St.
Milwaukee 4, Wis.

Allen-Sherman-Hoff Co.
259 East Lancaster Ave.
Wynnewood, Pa.

Allen-Sherman-Hoff Pump Co.
259 E. Lancaster Ave.
Wynnewood, Pa., second cover

Allis Chalmers Mfg. Co.
General Machinery Div.
1126 South 70th St.
Milwaukee 1, Wis., opp. p. 18

Allis-Chalmers Mfg. Co.
Buda Div.
1133 S. 70th St.
Milwaukee, Wis.

Allis Chalmers Mfg. Co.
Construction Machy. Div.
1126 South 70th St.
Milwaukee, Wis.

Louis Allis Co.
427 East Stewart St.
Milwaukee 7, Wis.

Allison Steel Mfg. Co.
South 19th Ave.
P. O. Box 6067
Phoenix, Ariz.

Alloy Rods Co.
York, Pa.

Alloy Steel & Metals Co.
1862 East 55th St.
Los Angeles 58, Calif.

All-State Welding Alloys Co., Inc.
249-55 Ferris Ave.
White Plains, N. Y.

Alpha Molykote Corp.
65 Harvard St.
Stamford, Conn.

Alphaduct Wire & Cable Co.
Ford Ave.
Milltown, N. J.

Aluminum Co. of America
1501 Alcoa Bldg.
Pittsburgh 19, Pa.

American Asbestos Textile Corp.
Stanbridge & Sterigere Sts.
Norristown, Pa.

American Air Filter Co., Inc.
215 Central Ave.
Louisville 8, Ky., page 209

American Blower Corp.
(Div. American-Standard)
Detroit 32, Mich.

American Brake Shoe Co.
230 Park Ave.
New York 17, N. Y.

American Brake Shoe Co.
American Steel Div.
389 East 14 St.
Chicago Heights, Ill.

American Brattice Cloth Corp.
Warsaw, Ind., page 194

American Brass Co.
Waterbury 20, Conn.

American Bridge Div.
U. S. Steel Corp.
525 Wm. Penn Place
Pittsburgh 30, Pa.

American Cast Iron Pipe Co.
Birmingham 2, Ala.

American Cain & Cable Co., Inc.
Wilkes-Barre, Pa.

American Chain & Cable Co., Inc.
York, Pa.

American Chain & Cable Co., Inc.
ACCO Casting Div.
Reading, Pa.

American Chain & Cable Co., Inc.
American Cable Div., Wilker-Barre, Pa.

American Chain & Cable Co., Inc.
Automotive & Aircraft Div.
601 Stephenson Bldg.
Detroit 2, Mich.

American Chain & Cable Co., Inc.
Hazard Wire Rope Div.
Wilkes-Barre, Pa.

American Chain & Cable Co., Inc.
Helicoid Gage Div.
Bridgeport 2 Conn.

American Chain & Cable Co., Inc.
Page Steel & Wire Div.
Monessen, Pa.

American Chain & Cable Co., Inc.
R-P&C Valve Div.
Reading, Pa.

American Chain & Cable Co., Inc.
Wright Hoist Div.
York, Pa.

American Coldset Corp.
87-89 Court St.
Paterson, N. J.

American Conveyor Co.
2133 S. Christiana Ave.
Chicago 13, Ill.

American Crucible Products Co.
Oberlin Rd.
Lorain, Ohio

American Cyanamid Co.
Explosives Dept.
30 Rockefeller Plaza

American Cyanamid Co.
Mineral Dressing Dept.
30 Rockefeller Plaza
New York 20, N. Y., page 150

American Emery Wheel Works
Richmond Square
Providence 1, R. I.

American Engineering Co.
Wheatsheaf Lane & Sepviva St.
Philadelphia, 37, Pa.

American Flexible Coupling Co.
Pittsburgh Ave.
Erie, Pa.

American Forge Co.
Niles, Calif., page 216

American Hard Rubber Co.
93 Worth St.
New York 13, N. Y.

American Hoist & Derrick Co.
63 South Robert St.
St. Paul 1, Minn.

American Instrument Co., Inc.
Silver Spring, Md.

American Lumber & Treating Co. Div.
Koppers Corp.
332 S. Michigan Ave.
Chicago 4, Ill.

American Locomotive Co.
143 Erie Blvd. Bldg.
Schenectady, N. Y.

American Machine & Foundry Co.
Leland Electric Co., Div.
1501 Webster
Dayton 1, Ohio

American Machine & Metals, Inc.
De Bothezat Fan Div.
East Moline, Ill.

American Machine & Metals, Inc.
U. S. Gauge Div.
Sellersville, Pa.

American-Marsh Pumps, Inc.
60 Capital Ave.
Battle Creek, Mich.

American Metal Co.
61 Broadway
New York, N. Y.

American Mine Door Co.
2037 Dueber Ave., S. W.
Canton 6, Ohio, page 197

American Oil Co.
555 Fifth Ave.
New York 17, N. Y.

American Optical Co.
14 Mechanic St.
Southbridge, Mass.

American Paulin System
1524 South Flower St.
Los Angeles 15, Calif.

American Potash & Chemical Corp.
3030 W. 6th St.
Los Angeles 54, Calif.

American Pulley Co.
4200 Wissahickon Ave.
Philadelphia 29, Pa., page 238

American Pulverizer Co.
1275 Macklin Ave.
St. Louis 10, Mo.

American Rectifier Co.
95 Lafayette St.
New York, N. Y.

American Rubber Mfg. Co.
1145 Park Ave.
Oakland 8, Calif.

American Sand-Banum Co., Inc.
Meadow Brook National Bank Bldg.
Freeport, N. Y.

American Smelting & Refining Co.
120 Broadway
New York 5, N. Y., page 236

American Smelting & Refining Co.
Federated Metals Div.
120 Broadway
New York 5, N. Y.

American Spectrographic Laboratories
557 Minna St.
San Francisco, Calif.

American Steel Dredge Co.
2511 West Taylor St.
Fort Wayne 1, Ind.

American Steel Foundries
Prudential Plaza
Chicago 1, Ill.

American Tractor Equipment Corp.
9131 San Leandro Blvd.
Oakland 3, Calif.

American Ventilating Hose Co.
100 Park Ave.
New York, N. Y.

American Water Softener Co.
Lehigh Ave. & Fourth St.
Philadelphia 33, Pa.

American Well Works
180 N. Broadway
Aurora, Ill.

American Zinc Sales Co.
818 Olive St.
St. Louis, Mo.

Ames Co., O.
Parkersburgh, W. Va.

Amex Iron Works, Inc.
25 E. 2nd St.
Oswego, N. Y.

Ammann Photogrammetric Engineers, Inc., Jack
Broadway at Tenth
San Antonio, Tex.

Ampco Metal, Inc.
1739 South 38th St.
Milwaukee, Wis.

Anaconda Wire & Cable Co.
25 Broadway
New York 4, N. Y., page 225

Analytical Measurements, Inc.
585 Main St.
Chatham, N. J., page 244

Anchor Plastics Corp.
36-36 36th St.
Long Island City, N. Y.

Anderson Mfg. Co., Albert & J. M.
289 A St.
Boston 10, Mass.

Ansonia Electrical Div.
Noma Electric Corp.
Ansonia, Conn.

Ansonia Wire & Cable Co.
111 Martin St.
Ashton, R. I.

Anthony Co.
Streator, Ill.

Antwerp Industrial Diamond Co.
535 Fifth Ave.
New York 17, N. Y.

Apache Powder Co.
Benson, Ariz.

Arcos Corp.
1500 S. 50th St.
Philadelphia 43, Pa.

Arizona Assay Office
815 N. 1st St.
Phoenix, Ariz.

Arizona Testing Laboratories
817 W. Madison St.
Phoenix, Ariz.

Armco Drainage & Metal Products, Inc.
703 Curtis St.
Middletown, Ohio

Armor Electric Mfg. Co.
1020 Holland St.
Erie, Pa.

Armour & Co.
1355 West 31st St.
Chicago 9, Ill.

Armstrong, Bray & Co.
5364 Northwest Hwy.
Chicago 30, Ill.

Aros Electric, Inc.
16 East 71st St.
New York 21, N. Y., page 201

Armstrong Rubber Co.
West Haven, Conn.

Arnold & Weigel Div.
Toledo Engineering Co., Inc.
3001 Sylvania Ave., Toledo 13, Ohio

Arro Expansion Bolt Co.
N. Boone Ave. Marion, Ohio

Arrow Hart & Hegeman Electric Co.
103 Hawthorne St.
Hartford 6, Conn.

Arrow Mfg. Co.
P. O. Box 4120
South Denver Station
Denver 9, Colo.

Arrow Tank Co.
16 Barnett St.
Buffalo 15, N. Y.

Arrowhead Steel Buildings, Inc.
367 Garfield Ave.
Duluth 6, Minn.

Asbestos Fibre Spinning Co.
North Wales, Pa.
Asbestos Mfg. Co.
Huntington, Ind.

Ashland Oil & Refining Co.
1409 Winchester Ave.
Ashland, Ky.

Associated Metals & Minerals Corp.
75 West St.
New York 6, N. Y.

Associated Research Inc.
3758 W. Belmont Ave.
Chicago 18, Ill.

Ateco Div.
Greenville Steel Car Corp.
Greenville, Pa.

Athey Products Corp.
5631 West 65th St.
Chicago 38, Ill., page 206

Atkins Saw Div.
Borg-Warner Corp.
402 S. Illinois St.
Indianapolis 9, Ind.

Atlantic Refining Co.
260 S. Broad St.
Philadelphia, Pa.

Atlantic Tank Corp.
1207 Tonnelle Ave.
North Bergen, N. J.

Atlas Corp.
Keller Ave. & Fruitville Pike
Lancaster, Pa.

Atlas Car & Mfg. Co.
1140 Ivanhoe Rd.
Cleveland 10, Ohio

Atlas Chain & Mfg. Co.
P. O. Box 708
West Pittston, Pa.

Atlas Conveyor Co.
Clintonville, Wis.

Atlas Copco Eastern, Inc.
151 Linwood Ave.
Paterson 25, N. J.

Atlas Copco Pacific, Inc.
930 Brittan Ave.
San Carlos, Calif.

Atlas Powder Co.
Concord Pike & Murphy Rd.
Wilmington, Del.

Atlas Steel Casting Co.
1963 Elmwood Ave.
Buffalo 7, N. Y.

Atlas Steels, Ltd.
Welland, Ontario, Canada

Atomic Research Corp.
527 S. Tejon St.
Colorado Springs, Colo.

Austin-Western Works
Construction Equipment Div.
Baldwin-Lima-Hamilton Corp.
Aurora, Ill., page 185

Auth Electric Co.
34-20 45th St.
Long Island City, N. Y.

Auto-Lite Battery Corp.
Toledo 1, Ohio

Automatic Electric Co.
1033 W. Van Buren St.
Chicago 7, Ill.

Automatic Switch Co.
391 Lakeside Ave.
Orange, N. J.

B

Babcock & Wilcox Co.
161 East 42nd St.
New York 6, N. Y.

Bacon-Greene & Milroy
29 Washington Ave.
P. O. Box 4343
Hamden, Conn.

Badger Malleable & Mfg. Co.
South Milwaukee, Wis.

Bailey Meter Co.
1050 Ivanhoe Rd.
Cleveland, Ohio

Baker & Co., Inc.
225 Grant Ave.
East Newark, N. J.

Baker Chemical Co., J. T.
Phillipsburg, N. J.

Baker-Lull Corp.
314 W. 90th St.
Minneapolis 20, Minn.

Baker Mfg. Co. Div., Allis-Chalmers Mfg. Co.
514 Stanford Ave.
Springfield, Ill.

Baker Raulang Co.
1250 West 80th St.
Cleveland 2, Ohio

Balderson, Inc.
Wamego, Kan.

Baldor Electric Co.
4351-67 Duncan Ave.
St. Louis 10, Mo.

Baldwin-Lima-Hamilton Corp.
Construction Equipment Div.
South Main St.
Lima, Ohio, page 185

Baldwin-Lima-Hamilton Corp.
Standard Steel Works Div.
Burnham, Pa.

Baldwin-Lima-Hamilton Corp.
Paschall P. O.
Philadelphia, Pa.

Barber-Greene Co.
400 North Highland Ave.
Aurora, Ill.

Barco Mfg. Co.
500 North Hough St.
Barrington, Ill.

Barnes Mfg. Co.
615 North Main St.
Mansfield, Ohio

Barrett Div.
Allied Chemical & Dye Corp.
40 Rector St.
New York 6, N. Y.

Barrett Haentjens & Co.
Hazleton, Pa.

Bartlett & Snow Co., C. O.
6200 Harvard Ave.
Cleveland 5, Ohio

Bates Co., Walter
500 Mills Rd.
Joliet, Ill.

Baxter Co., J. H.
120 Montgomery St.
San Francisco 4, Calif.

Batson Electronics Corp., J. A.
Waterloo, Neb.

Baughman Manufacturing Co., Inc.
Jerseyville, Ill.

Bausch & Lomb Optical Co.
837 St. Paul St.
Rochester 2, N. Y.

Bay City Shovels, Inc.
Bay City, Mich.

Bay State Abrasive Products Co.
12 Union St.
Westboro, Mass.

Beach & Co.
131 E. 8th St.
Leadville, Colo.

Beall Pipe & Tank Corp.
12005 N. Burgard St.
Portland 3, Ore.

Beaumont Birch Co.
1505 Race St.
Philadelphia 2, Pa.

Beckman Instruments, Inc.
2500 Fullerton Rd.
Fullerton, Calif.

Beckman Instruments, Inc.
Berkeley Div.
2200 Wright Ave.
Richmond, Calif.

Beech Aircraft Corp.
6600 East Central St.
Wichita, Kan.

Be-Ge Mfg. Co.
P. O. Box 67
Gilroy, Calif.

Bell Aircraft Corp.
Niagara Falls, N. Y.

Bellevue Industrial Furnace Co.
2971 Bellevue Ave.
Detroit 7, Mich.

Belmont Packing & Rubber Co.
Butler & Sepviva Sts.
Philadelphia 37, Pa.

Belmont Smelting & Refining Works, Inc.
330 Belmont Ave.
Brooklyn 7, N. Y.

Bemis Bro. Bag Co.
408 E. Pine St.
St. Louis 2, Mo.

Bennetts Chemical Laboratory, Inc.
901 S. 9th St.
Tacoma 3, Wash.

Bergen Wire Rope
152 Gregg St.
Lodi, N. J.

Berger & Sons, C. L.
37 Williams St.
Roxbury 19, Mass.

Beryllium Corp.
Tuckerton Rd.
Reading, Pa.

Bete Fog Nozzle, Inc.
309 Wells St.
Greenfield, Mass.

Bethlehem Foundry & Machine Co.
W. 2nd St.
Bethlehem, Pa.

Bethlehem Pacific Coast Steel Corp.
20th & Illinois Sts.
San Francisco, Calif.

Bethlehem Steel Co., Inc.
Bethlehem, Pa.

Bico, Inc.
3116 Valhalla Dr.
Burbank, Calif.

B-I-F Industries
Builders-Providence Div.
345 Harris Ave.
Providence, R. I., page 210

Bigelow Co.
72 River St.
New Haven, Conn.

Bigelow-Liptak Corp.
2550 West Grand Blvd.
Detroit 8, Mich.

Bingham Pump Co.
2800 N. W. Front St.
Portland, Ore.

Bin-Dicator Co.
13946 Kercheval St.
Detroit 15, Mich., page 248

Binks Mfg. Co.
3114 Carroll Ave.
Chicago 12, Ill.

Bird Machine Co.
South Walpole, Mass., page 290

Birdsboro Steel Foundry & Machine Co.
Birdsboro, Pa.

Bitco, Inc.
P. O. Box 929
Wallace, Idaho

Bixby-Zimmer Engr. Co.
961 Abingdon St.
Galesburg, Ill., page 178

Black & Decker Mfg. Co.
600 East Pennsylvania Ave.
Towson, Md.

Black Diamond Spad Co.
2108 Stratford Rd.
Richmond 25, Va.

Black Mfg. Co.
70 Okner Parkway
Livingston, N. J.

Black, Sivalls & Bryson, Inc.
7500 East 12th St.
Kansas City 26, Mo.

Blackhawk Mfg. Co.
5325 West Rogers
Milwaukee 46, Wis.

Black's Machine Shop
169 East Willow St.
Bishop, Calif.

Blaw-Knox Co.
Blaw-Knox Bldg.
300 Sixth Ave.
Pittsburgh 22, Pa.

Blaw-Knox Co.
Buffovak Equip. Div.
1543 Fillmore Ave.
Buffalo 11, N. Y.

Blaw-Knox Co.
Power Piping Div.
829 Beaver Ave.
Pittsburgh, Pa.

Blount Co., J. G.
Woodland St.
Everett 49, Mass.

Blue M Electric Co.
138 & Chatham St.
Blue Island, Ill.

Bodinson Manufacturing Co., Inc.
2401 Bayshore Blvd.
San Francisco, Calif.

Bohn Aluminum & Brass Corp.
1400 Lafayette Bldg.
Detroit 26, Mich.

Bolton Farm Packing Co., Inc.
P. O. Box 55
Newton 58, Mass., page 226

Bonded Scale & Machine Co.
38 Bellview
Columbus 7, Ohio

Booth Co.
333 West 14 South St.
Salt Lake City 4, Utah

Borden Engineering Co.
59 Clinton Ave.
Providence, R. I.

Borden Metal Products Co.
Elizabeth, N. J.

Borg-Warner Corp.
Morse Chain Co. Div.
Ithaca, N. Y.

Borne Scrymser Co.
632 S. Front St.
Elizabeth, N. J.

Boston Metals Co.
Baldt Anchor & Forge Div.
P. O. Box 350
Chester, Pa.

Boston Woven Hose & Rubber Co.
P. O. Box 1071
Boston 1, Mass.

Bowdil Co.
Boylan Ave., S. E.
Canton, Ohio

Bower Bearings Div.
Federal-Mogul-Bower Bearings, Inc.
3040 Hart Ave.
Detroit 14, Mich.

Bower Roller Bearing Co.
5040 Hart Avenue
Detroit 14, Mich.

Bowers Battery & Spark Plug Co.
Box 1262
Reading, Pa.

Boyles Bros. Drilling Co., Inc. (Utah)
1321 South Main St.
Salt Lake City 4, Utah, page 168

Boyles Bros. Drilling Co., Ltd.
(Vancouver)
1275-1291 Parker St.
Vancouver 6, Canada, page 177

Brabender Corp.
Rochelle Park, N. J.

Brad Foote Gear Works
1309 South Cicero Ave.
Cicero, Ill.

Brad Foote Gear Works
Pittsburgh Gear Co. Div.
Neville Island
Pittsburgh 25, Pa.

Bradley Pulverizer Co.
123 So. 3rd St.
Allentown, Pa.

Brady Co., W. H.
727 Glendale Ave.
Milwaukee 12, Wis.

Brammer Corp.
684 Broadway
New York 12, N. Y.

Brandeis, Goldschmidt & Co., Inc.
165 Broadway
New York 6, N. Y.

Branford Co.
131 Chestnut St.
New Haven, Conn.

Braun & Co., C. F.
1100 Fremont St.
Alhambra, Calif.

Braun Corp.
2260 East 15th St.
Los Angeles 21, Calif.

Brass Foundry Co.
713 S. Adams St.
Peoria 2, Ill.

Bridgeport Brass Co.
30 Grand St.
Bridgeport, Conn.

Bridgeport Chain & Mfg. Co.
962 Crescent Ave.
Bridgeport 1, Conn.

Briggs & Stratton Corp.
2711 North Thirteenth St.
Milwaukee 1, Wis.

Bright Star Battery Co.
Crooks & Getty Aves.
Clifton, N. J.

Bristol Co.
Waterbury 20, Conn.

Broderick & Bascom Rope Co.
4203 Union Blvd.
St. Louis 15, Mo.

Brooks Oil Co.
934 Ridge Ave.
Pittsburgh 12, Pa.

Brookville Locomotive Works
Steele Blvd.
Brookville, Pa., page 284

Brositex Products Corp.
50 Church St.
New York, N. Y., page 249

Brown, Inc., David
999 Beecher St.
San Leandro, Calif.

Browning Mfg. Co.
Maysville, Ky.

Bruning Co., Inc., Charles
4702 Montrose Ave.
Chicago 41, Ill.

Brunner & Lay Rock Bit of
Philadelphia, Inc.
2516 E. Cumberland St.
Philadelphia 25, Pa., page 226

Brunson Instrument Co., Inc.
1405 Walnut St., Kansas City 6, Mo.

Buck Inc., Leonard J.
1 Newark Ave.
Jersey City 2, N. J.

Bucyrus-Erie Co.
South Milwaukee, Wis.

Buell Engineering Co.
70 Pine St.
New York 5, N. Y., page 227

Buffalo Forge Co.
490 Broadway
Buffalo 5, N. Y.

Buffalo Hammer Mill Corp.
1245 McKinley
Buffalo 18, N. Y.

Buffalo Scale Co., Inc.
46 Letchworth St.
Buffalo 13, N. Y.

Buffalo Wire Works Co.
308 Terrace St.
Buffalo 2, N. Y.

Buff & Buff Mfg. Co.
329 Lamartine Ave.
Boston, Mass.

Bullard Co., E. D.
275 Eighth St.
San Francisco, Calif.

BullDog Electric Products Co.
Detroit 32, Mich.

Bunting Brass & Bronze Co.
715 Spencer St.
Toledo 9, Ohio

Burgess Battery Co.
Freeport, Ill.

Burndy Engrg. Co., Inc.
Post Rd.
Norwalk, Conn.

Burten Equipment Co., Inc.
4810 Firestone Blvd.
South Gate, Calif.

Butler Bin Co.
993 Blackstone Ave.
Waukesha, Wis.

Butler Manufacturing Co.
7400 East 13th St.
Kansas City, Mo.

Byers Co., A. M.
Clark Bldg.
Pittsburgh 22, Pa.

Byron Jackson Div.
Borg-Warner Corp.
P. O. Box 2017, Terminal Annex
Los Angeles 54, Calif.

C

Cabot, Inc., Samuel
Oliver Bldg.
Boston 9, Mass.

C & D Batteries, Inc.
Conshohocken, Pa.

C & D Div.
Yuba Manufacturing Co.
Perkins, Calif., page 224

Cadillac Malleable Iron Co.
Cadillac, Mich.

Cadman Mfg. Co., A. W.
2816 Smallman St.
Pittsburgh 22, Pa.

Calabrian Co., Inc.
141 Broadway
New York, N. Y., page 240

Calcium Chloride Institute
909 Ring Bldg.
Washington 6, D. C.

Caldwell Co., W. E.
2540 Brooks St.
Louisville 8, Ky.

Calebaugh Self Lubricating Carbon Co.
4637-39 Mulberry St.
Philadelphia 24, Pa.

Calgon, Inc.
Hagan Bldg.
Pittsburgh 30, Pa.

California Conduit & Cable Co.
2204 Orange St.
Alhambra, Calif.

California Testing Laboratories, Inc.
619 E. Washington Blvd.
Los Angeles 15, Calif.

Calumet Div.
Calumet & Hecla, Inc.
Calumet, Mich.

Cambridge Instruments Co., Inc.
3620 Grand Central Terminal
New York 17, N. Y.

Cambridge Wire Cloth Co.
152 Linkwood Rd.
Cambridge, Md.

Cameron Iron Works
P. O. Box 1212
Houston, Tex.

Campbell Co., E. K.
Manchester Ave., at 18th St.
Kansas City 26, Mo.

Canadian Aero Service, Ltd.
348 Queen St.
Ottawa, Ontario, Canada

Canadian Industries Ltd.
1253 McGill College Ave.
Montreal, Canada

Carboloy Dept.
General Electric Co.
11177 East Eight Mile Rd.
Detroit 32, Mich.

Carboline Co.
331 Thornton Ave.
St. Louis 19, Mo.

Carbon Engineering Corp.
P. O. Box 236
Slinger, Wis.

Carbone Corp.
400 Myrtle Ave.
Boonton, N. J.

Carborundum Co.
Box 337
Niagara Falls, N. Y.

Carborundum Co.
Refractories Div.
Perth Amboy, N. J.

Carbolineum Wood Preserving Co.
526 W. Highland Ave.
Milwaukee 3, Wis.

Card Iron Works, C. S.
2501 West 16th Ave.
Denver 4, Colo., page 218

Cardox Corp.
Hardsocg Div.
307 N. Michigan Ave.
Chicago 1, Ill.

Carey Mfg. Co., Philip
Lockland
Cincinnati 15, Ohio

Cargille Laboratories, Inc., R. P.
117 Liberty St.
New York 6, N. Y.

Carlile & Associates, J. C.
425 Cooper Bldg.
Denver 2, Colo.

Carlon Products Corp.
10225 Meech Ave.
Cleveland, Ohio

Carlyle Rubber Co.
103-107 Warren St.
New York, N. Y.

Carpco Manufacturing, Inc.
4120 Haines St.
Jacksonville, Fla., third cover

Carpenter Steel Co.
115 W. Bern St., Reading, Pa.

Carrier Conveyor Corp.
211 North Jackson
Louisville 2, Ky.

Carrier Corp.
300 South Geddes St.
Syracuse 1, N. Y.

Carroll Chain Co.
200 Bruck St.
Columbus, Ohio

Carter Co., Ralph B.
192 Atlantic St.
Hackensack, N. J.

Carver Pump Co.
Muscatine, Iowa

Case Co., J. I.
Industrial Div.
700 State St., Racine, Wis.

Cash Co., A. W.
P. O. Box 551
Decatur, Ill.

Catalytic Construction Co.
1528 Walnut St.
Philadelphia 2, Pa., page 202

Catawissa Valve & Fittings Co.
500 Mill St.
Catawissa, Pa.

Caterpillar Tractor Co.
Peoria 8, Ill.

C-A Wood Preserver Co.
6625 Delmar Blvd.
St. Louis 5, Mo.

Cement-Gun Co., Inc.
Allentown, Pa.

Central Frog & Switch Co.
Watson Rd.
Cincinnati 8, Ohio

Central Mine Equipment Co.
6200 North Broadway
St. Louis 15, Mo.

Central Mine Supply Co.
Mt. Vernon, Ill.

Central Scientific Co.
1700 Irving Park Road
Chicago 13, Ill.

Centric Clutch Co.
P. O. Box 175
Woodbridge, N. J.

Centrifugal & Mech. Industries, Inc.
146 President St.
St. Louis 18 Mo.

Century Electric Co.
1806 Pine St.
St. Louis 3, Mo.

Cessna Aircraft Co.
5800 Franklin Rd.
Wichita, Kan.

Chain Belt Co.
Shafer Bearing Div.
P. O. Box 57
Downers Grove, Ill.

Chain Belt Co.
4679 West Greenfield Ave.
Milwaukee 1, Wis.

Channon Corp., J. H.
1447-55 W. Hubbard St.
Chicago 22, Ill.

Chapman & Wood
536 Jefferson St., N. E.
Albuquerque, N. M.

Charcoal Corp. of America
726 Fairmont Ave.
Fairmont, W. Va.

Charleston Rubber Co.
35 Stark Industrial Park
Charleston, S. C., page 242

Charlton Laboratories
2340 S. W. Jefferson St.
Portland 7, Ore.

Chase Bag Co.
309 W. Jackson Blvd.
Chicago 6, Ill.

Chase Brass & Copper Co.
236 Grand St.
Waterbury 91, Conn.

Chatillon & Sons, John
85 Cliff St.
New York 38, N. Y.

Chattanooga Boiler & Tank Co.
1036 E. Main St.
Chattanooga 1, Tenn.

Cheatham Electric Switching Device
Co.
4780 Crittenden Drive
Louisville 9, Ky., page 284

Chelsea Fan & Blower Co.
639 South Ave.
Plainfield, N. J.

Chemical Construction Corp.
525 West 43rd St.
New York, N. Y.

Chemical Processing Co.
Box 829
Redwood City, Calif.

Chester Cable Corp.
521 Fifth Ave.
Chester, N. Y.

Chester Hoist Div.
National Screw Mfg. Co.
Lisbon, Ohio

Chicago Belting Div.
Chicago-Allis Mfg. Corp.
113 N. Green St.
Chicago 7, Ill.

Chicago Bridge & Iron Co.
332 S. Michigan Ave.
Chicago 4, Ill.

Chicago Expansion Bolt Co.
1338 W. Concord Pl.
Chicago 22, Ill.

Chicago Eye Shield Co.
2304 Warren Blvd.
Chicago, Ill.

Chicago Gear Mfg. Co.
2823 W. Fulton St.
Chicago 12, Ill.

Chicago Perforating Co.
2445 24th Pl., Chicago 8, Ill.

Chicago Pneumatic Tool Co.
6 East 44th St.
New York 17, N. Y.

Chicago Pulley & Shafting Co.
13 N. Desplaines St.
Chicago 6, Ill.

Chicago Rawhide Mdg. Co.
1279 Elston Ave.
Chicago, Ill.

Chicago Wheel & Mfg. Co.
1101 W. Monroe St.
Chicago 7, Ill.

Chiksan Co.
330 North Pomona Ave.
La Brea, Calif.

Chisholm-Moore Hoist Corp.
5045 Fremont Ave.
Tonawanda, N. Y.

Christensen Diamond Products Co.
1937 South 2nd West St.
Salt Lake City 10, Utah, page 12

Christian Engineers, J. D.
480 Potrero Ave.
San Francisco 10, Calif.

Chrysler Corp.
Dodge Truck Div.
7900 Joseph Campau Ave.
Detroit, Mich.

Chrysler Industrial Engine Div.
Wyandotte, Mich.

Ciba Co.
631 Greenwich St.
New York 14, N. Y.

Cincinnati Electrical Tool Co.
2684 Madison Rd.
Cincinnati 9, Ohio

Cincinnati Mine Machinery Co.
Mining Div.
2980 Spring Grove Ave.
Cincinnati 25, Ohio

Cincinnati Rubber Mfg. Co.
Franklin Ave. & Norwood St.
Cincinnati, Ohio

Cincinnati Steel Castings Co.
Spring Grove
Alabama & Bates Aves.
Cincinnati 25, Ohio

Cities Service Oil Co.
54 Wall St.
New York 5, N. Y.

Circle F Mfg. Co.
720 Monmouth St.
Trenton 4, N. J.

Clapp Instrument Co.
Webster, Mass.

Clarage Fan Co.
619 Porter St.
Kalamazoo 16, Mich.

Clark Brothers Co., Div.
Dresser Operations, Inc.
P. O. Box 560, Olean, N. Y.

Clark Controller Co.
1146 E. 152nd St.
Cleveland 10, Ohio

Clark Equipment Co.
Construction Machinery Div.
331 Miller St.
Benton Harbor, Mich.

Clark Equipment Co.
Transmission Div.
Jackson 1, Mich.

Clarkson Co.
564 Market St.
San Francisco 4, Calif.

Clarkson Manufacturing Co.
Nashville, Ill.

Cleveland Chain & Mfg. Co.
545 Henry St.
Cleveland 5, Ohio

Cleveland Crane & Engrg. Co.
5866 E. 289 St.
Wickliffe, Ohio

Cleveland Electric Motor Co.
5213 Chester Ave.
Cleveland 3, Ohio

Cleveland Vibrator Co.
2828 Clinton Ave.
Cleveland 13, Ohio

Cleveland Wire Cloth & Mfg. Co.
3573 East 78th St.
Cleveland 5, Ohio

Cleveland Worm & Gear Co.
3249 East 80th St.
Cleveland 4, Ohio

Climax Engine & Pump Mfg. Co.
Clinton, Iowa

Climax Molybdenum Co.
500 Fifth Ave.
New York, N. Y.

Cline Truck Co.
3501 Gardner Ave.
Kansas City 20, Mo.

Cling-Surface Co.
1032 Niagara St.
Buffalo 13, N. Y.

Clipper Belt Lacer Co.
974 Front St., N. W.
Grand Rapids 2, Mich.

Clipper Mfg. Co.
2800 Warwick St.
Kansas City 8, Mo.

Clyde Iron Works, Inc.
29th Ave. West & Michigan St.
Duluth, Minn.

Coast Mfg. & Supply Co.
Box 71
Livermore, Calif.

Coast Metals, Inc.
Redneck Ave.
Little Ferry, N. J.

Coates Steel Pdts. Co.
Greenville, Ill.

Coeur d'Alene Hardware & Foundry Co.
Wallace, Idaho

Coffing Hoist Div.
Duff-Norton Co.
800 Walter St.
Danville, Ill.

Collyer Insulated Wire Co.
249 Roosevelt Ave.
Pawtucket, R. I.

Colorado Assaying Co.
2013 Welton St.
Denver 1, Colo.

Colorado Fuel & Iron Corp.
Continental Oil Bldg.
Denver 1, Colo., page 164

Colorado Fuel & Iron Co.
John A. Roebling's Sons Co. Div.
640 South Broad St.
Trenton 2, N. J., page 164

Colorado Fuel & Iron Corp.
Wickwire Spencer Steel Div.
575 Madison Ave.
New York 22, N. Y., page 164

Colorado Iron Works
Mine & Smelter Supply Co.
1624 17th St.
Denver 2, Colo., page 186

Columbia Electric Mfg. Co.
4619 Hamilton Ave., N. E.
Cleveland 14, Ohio

Columbian Steel Tank Co.
1509 West 12th St.
Kansas City 1, Mo.

Columbus Conveyor Co.
869 W. Goodale Blvd.
Columbus 8, Ohio

Columbus Forge & Iron Co.
544 W. First Ave.
Columbus 8, Ohio

Combustion Engineering Inc.
200 Madison Ave.
New York 16, N. Y.

Combustion Engineering, Inc.
Raymond Div.
1323 N. Branch St.
Chicago 22, Ill.

Commercial Shearing & Stamping Inc.
1775 Lorain Ave.
Youngstown, Ohio

Commercial Solvent Corp.
260 Madison Ave.
New York 16, N. Y.

Commercial Testing & Engrg. Co.
228 North LaSalle St.
Room 924
Chicago 1, Ill.

Compton, Inc.
P. O. Box 1946
Clarksburg, W. Va.

Conco Engineering Works
Mendota, Ill.

Condenser Service & Engineering Co.
150 Observer Highway
Hoboken, N. J.

Cone-Drive Gears Div.
Michigan Tool Co.
7171 E. McNichols Rd.
Detroit 12, Mich.

Conley Frog & Switch Co.
Bodley Ave., P. O. Box 3188
Memphis 9, Tenn.

Connellsville Mfg. & Mine Supply Co.
Connellsville, Pa.

Conrader Co., R.
236 W. 17th St.
Erie, Pa.

Consolidated Diamond Drill Corp., Ltd.
33 Melinda St.
Toronto, Ontario, Canada

Consolidated Electrodynamics Corp.
300 N. Sierra Madre Villa
Pasadena, Calif.

Consolidated Iron-Steel Mfg. Co.
1290 E. 53rd St.
Cleveland 14, Ohio

Consolidated Packaging Machinery Corp.
1400 West Ave.
Buffalo 13, N. Y.

Construction Machy. Co.
Box 120
Waterloo, Iowa

Continental Battery Mfg. Corp.
1914 S. Central Expressway
Dallas, Tex.

Continental-Diamond Fibre Div.
Budd Inc.
Newark, Del.

Continental Electric Co.
325 Ferry St.
Newark 5, N. J.

Continental Gin Co.
Industrial Div.
P. O. Box 2614
Birmingham 2, Ala.

Continental Mineral Processing Co.
First National Bank Bldg.
Cincinnati 2, Ohio

Continental Motors Co.
Muskegon, Mich.

Continental Oil Co.
P. O. Box 2197
Houston 1, Texas

Continental Ore Corp.
500 5th Ave.
New York 36, N. Y.

Continental Rubber Works
1939 Liberty St.
Erie, Pa.

Convair, Inc.
Box 9671
Pittsburgh 26, Pa.

Conveyor Co.
3260 E. Slauson Ave.
Los Angeles 58, Calif.

Conveyor Systems, Inc.
325 S. California Ave.
Chicago, Ill.

Conway Clutch Co.
2745 Colerain Ave.
Cincinnati 25, Ohio

Cooper-Bessemer Corp.
Mt. Vernon, Ohio

Cooper Split Roller Bearing Corp.
2021 Milford Drive
Pittsburgh 34, Pa.

Coors Porcelain Co.
600 Ninth St.
Golden, Colo.

Coover Railroad Track Brace Co.
P. O. Box 254
Dayton 1, Ohio

Copperweld Steel Co.
9th St. & Allegheny Ave.
Glassport, Pa.

Coppus Engineering Co.
344 Park Ave.
Worcester 2, Mass.

Corhart Refractories Co.
16th & Lee Sts.
Louisville 10, Ky.

Corning Glass Works
Corning, N. Y.

Cotta Transmission Co.
2300 11th St.
Rockford, Ill.

Craig Carroll Co.
1704 S. E. 22nd Ave.
Portland 15, Ore.

Crane Co.
836 South Michigan Ave.
Chicago 5, Ill.

Crane Puller Co.
Waltham 54, Mass.

Crescent Belt Fastener Co.
480 Lexington Ave.
New York, N. Y.

Crescent Insulated Wire & Cable Co.
Olden & Taylor Aves.
Trenton 5, N. J.

Critchett & Ferguson
105 S. Santa Fe St.
El Paso, Tex.

Crosby Steam Gage & Valve Co.
43 Kendrick St.
Wrentham, Mass.

Cross Engineering Co.
178 Dundaff St.
Carbondale, Pa.

Crouse Hinds Co.
Wolf & Seventh North Sts.
Syracuse 1, N. Y.

Crucible Steel Co. of America
Oliver Bldg., Mellon Square
Pittsburgh 22, Pa., page 147

Cullman Wheel Co.
1344 W. Altgeld St.
Chicago 14, Ill.

Cummings Jr., & Associates, Robt. A
300 Sixth Ave.
Pittsburgh 22, Pa.

Cummins Engine Company, Inc.
Fifth & Union Sts.
Columbus, Ind.

Curtin-Howe Corp.
405 Lexington Ave.
New York, N. Y.

Curtis Manufacturing Co.
1905 Kienlen Ave.
St. Louis 20, Mo.

Curtiss-Wright Corp.
Electronics Div.
631 Central Ave.
Carlstadt, N. J.

Custodis Construction Co., Inc.
157 Chambers St.
New York 7, N. Y.

Custom Assay Office
Box 811
El Paso, Tex.

Cutler-Hammer, Inc.
553 North 12th
Milwaukee 1, Wis.

D

D-A Lubricant Co., Inc.
1311 W. 29th St.
Indianapolis 23, Ind.

Dagley Mfg. Co.
1217 East Sixth St.
Joplin, Mo.

Dake Corp.
Grand Haven, Mich.

Daniels Co. Contractors, Inc.
26 North Fifth St.
Indiana, Pa.

Darling Valve & Mfg. Co.
Foot of Walnut St.
Williamsport, Pa.

Dart Truck Co.
2621 Oak St.
Kansas City, Mo., page 199

Darworth, Inc.
Cuprinol Div.
Simsbury, Conn.

Davenport Besler Corp.
2305 Rockingham Rd.
Davenport, Iowa

Davey Compressor Co.
Kent, Ohio

Davis Instrument Co.
513 East 36th St.
Baltimore 18, Md.

Dayton Rubber Co.
2342 West Riverview Ave.
Dayton 1, Ohio

Davidson Co., M. T.
7 Dey St.
New York 7, N. Y.

Davis Foundry & Machine Works
Old Furnace Road
Rome, Ga.

Dean Hill Pump Co.
4000 E. 16th St.
Indianapolis 7, Ind.

Deason & Nichols
160 South West Temple St.
Salt Lake City 1, Utah

Deister Concentrator Co.
901 Glasgow Ave.
Fort Wayne 1, Ind.

Deister Machine Co.
1933 East Wayne St.
Fort Wayne 4, Ind.

DeLaval Steam Turbine Co.
855 Nottingham Way
Trenton 2, N. J.

DeLong Engineering Corp.
29 Broadway
New York 6, N. Y.

Delta-Star Electric Division
H. K. Porter Co., Inc.
2437 Fulton St.
Chicago 12, Ill.

Deltron Electric Products, Inc.
Ebensburg, Pa.

Deming Co.
42 Broadway
Salem, Ohio

Dempster Brothers, Inc.
Springdale Ave. at Southern R. R.
Knoxville 17, Tenn.

Denver Equipment Co.
P. O. Box 5268
Denver 17, Colo., page 176

Denver Fire Clay Co.
2301 Blake St., P. O. Box 5510
Denver, Colo.

DeSousa Co., Inc., J. E.
217 Broadway
New York 7, N. Y., page 222

Detectron Corp.
5528 Vineland Ave.
North Hollywood, Calif.

Detroit Diesel Engine Div.
General Motors Corp.
13400 W. Outer Dr.
Detroit 28, Mich., page 182

Detroit Hoist & Machine Co.
8224 Morrow St.
Detroit 11, Mich.

DeWalt, Inc.
Fountain Ave.
Lancaster, Pa.

Dewey & Almy Chemical Co.
62 Whittemore Ave.
Cambridge, Mass.

Diamond Chain Co., Inc.
402 Kentucky Ave.
Indianapolis 7, Ind.

Diamond Drill Carbon Co.
244 Madison Ave.
New York 16, N. Y.

Diamond Drill Contracting Co.
South 18 Stone St.
Spokane 15, Wash.

Diamond Iron Works Div.
Goodman Mfg. Co.
Halsted St. & 48th Pl.
Chicago 9, Ill.

Diamond Mfg. Co.
W. Eighth St.
Wyoming, Pa.

Diamond Power Specialty Corp.
Lancaster, Ohio

Diamond Products, Inc.
336 Prospect Ave.
Elyria, Ohio, page 246

Dick Co., R. & J.
Sade St.
Passaic, N. J.

Dicke Tool Co.
1201 Warren Ave.
Downers Grove, Ill.

Dickinson Laboratories, Inc.
1300 W. Main St.
El Paso, Tex.

Diehl Mfg. Co.
1199 Finderne Ave.
Somerville, N. J.

Diesel Energy Corp.
82 Beaver St.
New York, N. Y.

Dietz Co., Henry G.
Coral Designs Div.
12-16 Astoria Blvd.
Long Island City 2, N. Y.

Dietzgen Co., Eugene
218 E. 23rd St.
New York 10, N. Y.

Differential Steel Car Co.
Findlay, Ohio

Dings Magnetic Separator Co.
4740 West Electric Ave.
Milwaukee 46, Wis., page 231

Disston Div., Henry
H. K. Porter Co., Inc. of Pittsburgh
Unruh & Milnor Sts.
Phila. 35, Pa.

Dixon Crucible Co., Joseph
Monmouth & Wayne St.
Jersey City 3, N. J.

Dixon Valve & Coupling Co.
Philadelphia 22, Pa.

Dodge Mfg. Corp.
South Union St.
Mishawaka, Ind.

Dominion Engineering Co., Ltd.
First Ave.
Lachine, P. Q., Canada

Dominion Steel & Coal Corp., Ltd.
Canada Cement Bldg.
Montreal, Quebec, Canada

Dooley Brothers
1201 South Washington St.
Peoria, Ill.

Dorr Oliver, Inc.
Barry Place
Stamford, Conn.

Dorsey Trailers
Elba, Alabama

Dow Chemical Co.
Hopkins Bldg.
Midland, Mich.

Dow Corning Corp.
Midland, Mich.

Dravo Corp.
Neville Island
Pittsburgh 25, Pa.

Dresser-Ideco Co.
875 Michigan Ave.
Columbus, Ohio

Dresser Industries, Inc.
Roots-Connersville Blower Div.
900 West Mount St.
Connersville, Ind.

Dresser Mfg. Div.
Dresser Industries, Inc.
Bradford, Pa.

Drilling Accessory & Mfg. Co., Inc.
2006 S. Industrial
Dallas, Tex.

Drott Mfg. Co.
3841 West Wisconsin Ave.
Milwaukee 8, Wis.

Drullard Co., Howard
1026 Folsom St.
San Francisco 3, Calif.

Ducon, Inc.
153 East Second St.
Mineola, N. Y.

Duff Norton Co.
2709 Preble Ave.
Pittsburgh 30, Pa.

Dumore Co.
1300 17th St.
Racine, Wis.

DuPont de Nemours & Co., E. I.
Wilmington, Del.

DuPont de Nemours & Co., Inc., E. I.
Explosives Div.
2420 Nemours Bldg.
Wilmington 98, Del., page 161

DuPont de Nemours & Co., Inc., E. I.
Fabrics Div.
Wilmington 98, Del.

DuPont de Nemours & Co., Inc., E. I.
Ventube Div.
Fairfield 6, Conn.

Durakool, Inc.
1010 N. Main St.
Elkhart, Ind.

Duriron Co., Inc.
450 North Findlay St.
Dayton 1, Ohio

Dustex Corp.
Box 2520
1758 Walden Ave.
Buffalo 25, N. Y.

Dynamatic Div.
Eaton Manufacturing Co.
3307 14th Ave.
Kenosha, Wis.

E

Eagle Iron Works
P. O. Box 934
Des Moines 4, Iowa, page 198

Eagle-Picher Co.
American Bldg.
Cincinnati 1, Ohio

Eastern Constructors, Inc.
Poland, Ohio

Eastern Electro-Casting Co., Ltd.
1980 Sherbrooke St., W.
Montreal, Que., Canada

Eastman Mfg. Co.
12th St.
Manitowoc, Wis.

Eastman-Pacific Co.
2320 East Eighth St.
Los Angeles 21, Calif.

Easton Car & Construction Co.
Easton, Pa.

Eaton Mfg. Co.
739 East 140th St.
Cleveland, Ohio

Eberbach Corp.
200 E. Liberty St.
Ann Arbor, Mich.

Eberhardt Denver Co.
Subsidiary of Morse Chain Co.
1408 W. Colfax Ave.
Denver 4, Colo.

Thomas A. Edison, Inc.
Edison Storage Battery Div.
Lakeside Ave.
West Orange, N. J.

Edward Valves, Inc.
1200 W. 145th St.
East Chicago, Ind.

Edwards Wire Rope
P. O. Box 513
San Francisco, Calif.

Eimco Corp.
634 South Fourth West St., Box 300
Salt Lake City 10, Utah, page 158

Eisenhauer Laboratories
322 S. San Pedro St.
Los Angeles 13, Calif.

Eisler Engineering Co.
740 S. 13th St.
Newark 3, N. J.

Elastic Stop Nut Corp. of America
2330 Vauxhall Rd.
Union, N. J.

Electric Controller & Mfg. Co. Div.
Square D. Co.
4500 Lee Rd.
Cleveland 28, Ohio

Electric Machinery Mfg. Co.
800 Central Ave.
Minneapolis 13, Minn.

Electric Materials Co.
North East, Pa.

Electric Service Mfg. Co.
17th & Cambria Sts.
Philadelphia 32, Pa.

Electric Specialty Co.
211 South St.
Stamford, Conn.

Electric Steel Foundry Co.
2141 North West 25th Ave.
Portland 10, Ore.

Electric Storage Battery Co.
Exide Industrial Div.
42 So. 15th St.
Philadelphia 2, Pa.

Electrical Engineers Equipment Co.
25th St. & Division Ave.
Melrose Park, Ill.

Electrical Fittings Corp.
37-50 57 St.
Woodside 77, N. Y.

Elektrokemisk A. S.
101 Park Ave.
New York, N. Y., page 286

Electro Lift, Inc.
204 Sargeant Ave.
Clifton, N. J.

Electro Refractories & Abrasives Corp.
Willets Rd.
Buffalo 19, N. Y.

Electro Products Laboratories
4501 North Ravenswood Ave.
Chicago, Ill.

Electroline Co.
4121 S. La Salle St.
Chicago 9, Ill.

Electronic Products Co.
111 E. Third St.
Mt. Vernon N. Y.

Elgin National Watch Co.
2435 N. Naomi St.
Burbank, Calif.

Elkhart Brass Mfg. Co.
1302 W. Beardsley Ave.
Elkhart, Ind.

Ellicott Machine Corp.
1657 Bush St.
Baltimore 30, Md.

Elliott Co.
Crocker-Wheeler Div.
Ampers 5, N. J.

Elliott Co.
900 North Fourth Ave.
Jeannette, Pa.

Elliott Co., B. K.
124 Sixth St.
Pittsburgh 22, Pa.

Elliott Co.
Ridgway Div.
Ridgway, Pa.

Elliott Service Co., Inc.
30 North MacQuesten Pkwy.
Mt. Vernon, N. Y.

El Paso Testing Laboratories
El Paso, Tex.

Elreco Corp.
2900 Cormany Ave.
Cincinnati 25, Ohio

El-Tronics Inc.
2647 N. Howard St.
Philadelphia 33, Pa.

Emery Industries, Inc.
Carew Tower
Cincinnati 2, Ohio

Empire Steel Castings, Inc.
Box 139
Reading, Pa.

Endicott Forging & Mfg. Co.
1901 North St.
Endicott, N. Y.

Engelhard, Inc., Charles
850 Passaic Ave.
East Newark, N. J.

Engineers Syndicate, Ltd.
5011 Hollywood Blvd.
Hollywood, Calif.

Enley Products, Inc.
1236 Broadway
Brooklyn 21, N. Y.

Ensign-Bickford Co.
Simsbury, Conn., page 4

Ensign Electric & Mfg. Co.
914 Adams Ave.
Huntington 4, W. Va.

Enterprise Wheel & Car Corp.
Bristol
Tenn., Va.

Equipment Engineers
41 Sutter St.
San Francisco 4, Calif., page 289

Equitable Paper Bag Co., Inc.
45-50 Van Dam St.
Long Island City 1, N. Y.

Equitable Powder Mfg. Co.
East Alton, Ill.

Erico Products, Inc.
2070 E. 61st Pl.
Cleveland 3, Ohio

Erie City Iron Works
1422 East Ave.
Erie, Pa.

Erie Pump & Engine Works
145 Glenwood Ave.
Medina, N. Y.

Erie Strayer Co.
Erie, Pa.

Eriez Mfg. Co.
202 Magnet Dr.
Erie, Pa.

Essex Wire Corp.
Paranite Wire & Cable Div.
1601 Wall St.
Fort Wayne 6, Ind.

Essick Manufacturing Co.
1950 Santa Fe Ave.
Los Angeles 21, Calif.

Esso Standard Oil Co.
15 W. 51st St.
New York 19, N. Y.

Esterline-Angus Co., Inc.
P. O. Box 596
Indianapolis 6, Ind.

Ettco Wire & Cable Corp.
75 Onderdonk Ave.
Brooklyn 37, N. Y.

Euclid Div.
General Motors Corp.
1361 Chardon Rd.
Cleveland 17, Ohio

Euclid Electric & Mfg. Co.
50 Edwards St.
Madison, Ohio

Eutectic Welding Alloys Corp.
40-40 172nd St.
Flushing 58, N. Y.

Everlasting Valve Co.
49 Fisk St.
Jersey City 5, N. J.

Exide Industrial Div.
Electric Storage Battery Co.
42 South 15th St.
Philadelphia 2, Pa., page 235

Exolon Co.
East Niagara St.
Tonawanda, N. Y.

F

F. A. B. Mfg. Co.
1249 67th St.
Oakland 8, Calif.

Fafnir Bearing Co.
37 Booth St.
New Britain, Conn.

Fahrenwald Co., A. W.
E. 3500 Riverside
Spokane, Wash., page 249

Failing Co., George E.
Enid, Okla.

Fairbanks Co.
393 Lafayette St.
New York 3, N. Y.

Fairbanks-Morse & Co.
600 South Michigan Ave.
Chicago 5, Ill.

Fairchild Aerial Surveys, Inc.
224 E. 11th St.
Los Angeles, Calif.

Fairmont Machinery Co.
Fairmont, W. Va.

Falcon Alarm Co., Inc.
243 Broad St.
Summit, N. J. page 249

Falk Corp.
3049 West Canal St.
Milwaukee 1, Wis., page 9

Farrel-Birmingham Co., Inc.
25 Main St.
Ansonia, Conn.

Farrell-Cheek Steel Co.
Sandusky, Ohio

Farris Flexible Valve Corp.
463 Commercial Ave.
Palisades Park, N. J.

Farval Corp.
3249 East 80th St.
Cleveland 4, Ohio

Fawick Airflex Co., Inc.
9919 Clinton Ave.
Cleveland 11, Ohio

Federal Bearings Co., Inc.
Poughkeepsie, N. Y.

Federal Electric Co.
Pacific Electric Switchgear Div.
5815 3rd St.
San Francisco 24, Calif.

Federal-Mogul Corp.
11031 Shoemaker
Detroit 13, Mich.

Federal Motor Truck Co.
5780 Federal Ave.
Detroit 9, Mich.

Federal Pacific Electric Co.
50 Paris St.
Newark 5, N. J.

Federal Pipe & Tank Co.
6851 E. Marginal Way
Seattle, Wash.

Federal Telephone & Radio Div.
International Telephone and Telegraph Corp.
100 Kingsland Rd.
Clifton, N. J.

Femco, Inc.
Irwin, Pa.

Fenwick Mfg. Co.
134 Rome St.
Newark 5, N. J.

Filer & Stowell Co.
147 E. Becker St.
Milwaukee 7, Wis.

Filter Fabric Inc.
1279 West Third St.
Cleveland 3, Ohio

Filtration Engineers, Inc.
155 Oraton St.
Newark 4, N. J.

Firestone Tire & Rubber Co.
12 South Main St.
Akron 17, Ohio

Firth Sterling, Inc.
3113 Forbes St.
Pittsburgh 30, Pa.

Fisher & Porter Co.
415 Warminster Rd.
Hatboro, Pa.

Fisher Leather Belting Co., Inc.
325 N. Third St.
Philadelphia 6, Pa.

Fisher Research Laboratory, Inc.
1961 University Ave.
Palo Alto, Calif.

Fisher Scientific Co.
717 Forbes St.
Pittsburgh 19, Pa.

Fiske Bros. Refining Co.
Lubriplate Div.
129 Lockwood St.
Newark 5, N. J.

Fitzgibbons Boiler Co.
101 Park Ave.
New York 17, N. Y.

Fitz Simons & Connell Dredge & Dock Co.
10 South LaSalle St.
Chicago 3, Ill.

Fletcher & Co., J. H.
707 W. 7th St.
Huntington, W. Va.

Flexaust Co.
100 Park Ave.
New York 17, N. Y.

Flexible Steel Lacing Co.
4607 Lexington St.
Chicago 44, Ill.

Flexible Tubing Co.
Guilford, Conn.

Flexo Products, Inc.
1468-70 West 9th St.
Cleveland 13, Ohio

Flintkote Co.
30 Rockefeller Plaza
New York 26, N. Y.

Flocker & Co., John
644 Grant St.
Pittsburgh 19, Pa.

Flood City Brass & Elec. Co.
Johnstown, Pa.

Flory Mfg. Co., S.
Bangor, Pa.

Fluor Products Co.
12000 E. Washington Blvd.
Whittier, Calif.

Fly Ash Arrestor Corp.
P. O. Box 1883
Birmingham 1, Ala.

Foley Bros. Construction Co.
Pleasantville, N. Y.

Food Machinery & Chemical Corp.
Packing Equipment Div.
P. O. Box 552
Riverside, Calif.

Food Machinery & Chemical Corp.
Peerless Pump Div.
301 West Ave. 26
Los Angeles 31, Calif.

Food Machinery & Chemical Corp.
Westvaco Mineral Products Div.
Westvaco Chlor-Alkali Div.
161 E. 42nd St.
New York 17, N. Y.

Foote Bros. Gear & Machine Corp.
4545 S. Western Blvd.
Chicago 9, Ill.

Foote Mineral Co.
18 West Chelton Ave.
Philadelphia, Pa.

Ford Motor Co.
P. O. Box 658
Dearborn, Mich.

Forker Corp.
2044 Random Rd.
Cleveland 6, Ohio

Foster Co., L. B.
P. O. Box 1647
Pittsburgh 30, Pa.

Foster Wheeler Corp.
165 Broadway
New York 6, N. Y.

Fourwheel Drive Auto Co.
Clintonville, Wis.

Foxboro Co.
Foxboro, Mass.

Franklin Brass Foundry Co.
Pear & Richmond Sts.
Reading, Pa.

Franklin Plastics Co.
315 Grant St.
Franklin, Pa.

Frantz Co., Inc., S. G.
Brunswick Pike & Kline Ave.
P. O. Box 1138
Trenton 5, N. J.

Frazier Davis Const. Co.
1319 Macklind Ave., St. Louis, Mo.

Frog, Switch & Mfg. Co.
Carlisle, Pa.

Frontier Bronze Co.
4870 Packard Rd.
Niagara Falls, N. Y.

Frontier Industries
Manzel Div.
315 Babcock St.
Buffalo 10, N. Y.

Fruehauf Trailer Co.
10940 Harper Ave.
Detroit 32, Mich.

Fuel Process Co.
D at 10th St.
South Charleston, W. Va.

Fuller Co.
Catasauqua, Pa.

Fuller Manufacturing Co.
1410 North Burdick St.
Kalamazoo, Mich.

Fulton Bag & Cotton Mills
Bag Div.
1400 Annunciation St.
New Orleans 13, La.

Fyr-Fyter Co.
221 Crane St.
Dayton 1, Ohio

G

G. & W. Electric Specialty Co.
7782 Dante Ave.
Chicago 19, Ill.

Gallagher Co.
P. O. Box 209
Salt Lake City 10, Utah, page 167

Galion Allsteel Body Co.
Galion, Ohio

Galion Iron Works
Galion, Ohio

Galland Henning Mfg. Co.
Nopak Div.
2753 South 31st St.
Milwaukee 46, Wis.

Gardner Denver Co.
Quincy, Ill., page 160

Gardner Electric Mfg. Co.
4227 Hollis St.
Emeryville 8, Calif.

Garlock Packing Co.
402 East Main St.
Palmyra, N. Y.

Gar Wood Industries, Inc.
Wayne, Mich.

Gates Engrg. Co.
100 South West St.
Wilmington 99, Del.

Gates Rubber Co.
999 South Broadway
Denver 17, Colo., page 198

Gatke Corp.
246 N. La Salle St.
Chicago 1, Ill.

Gear Specialties, Inc.
2635 W. Medill Ave.
Chicago 47, Ill.

General American Transportation Corp.
135 South LaSalle St.
Chicago 90, Ill.

General American Transportation Corp.
Louisville Dryer Div.
139 South Fourth St.
Louisville, Ky.

General Aniline & Film Corp.
Ozalid Div.
400 Ozaway
Johnson City, N. Y.

General Cable Corp.
420 Lexington Ave.
New York 17, N. Y.

General Chemical Div.
Allied Chemical & Dye Corp.
Baker & Adamson Products
40 Rector St.
New York 6, N. Y., page 240

General Electric Co.
Apparatus Sales Div.
Schenectady 5, N. Y.

General Electric Co.
Trumbull Electric Dept.
Plainville, Conn.

General Electric Co.
Construction Materials Div.
1285 Boston Ave.
Bridgeport 2, Conn.

General Electric Co.
Ind. Haulage Div.—Loco. & Car Equip. Divs.
2901 East Lake Rd.
Erie, Pa.

General Engineering Co., Ltd.
100 Adelaide St., W.
Toronto 1, Canada

General Equipment & Mfg. Co.
120 S. Campbell St.
Louisville, Ky.

General Chemical Div.
Allied Chemical & Dye Corp.
40 Rector St.
New York 6 N. Y.

General Dry Batteries Co. Div.
P. R. Mallory & Co. Inc.
13000 Athens Ave.
Cleveland 7, Ohio

General Mills, Inc.
Fourth St. & Second Ave., S.
Minneapolis, Minn.

General Motors Corp.
Allison Div.
4700 West Tenth St.
Indianapolis 6, Ind., page 211

General Motors Corp.
Electro-Motive Div.
La Grange, Ill.

General Motors Corp.
Hyatt Bearings Div.
427 Middlesex St.
Harrison, N. J.

General Motor Corp.
New Departure Div.
Bristol, Conn.

General Nuclear Corp.
550 Fifth Ave.
New York 38, N. Y.

General Refractories, Co.
1520 Locust St.
Philadelphia, Pa., page 195

General Splice Corp.
15 Whitehall St.
New York, N. Y.

General Steel Warehouse Co., Inc.
Gensco Tool Div.
1830 North Kostner Ave.
Chicago 39, Ill.

General Switch Corp.
45 Roebling St.
Brooklyn 11, N. Y.

General Tire & Rubber Co.
1708 Englewood Ave.
Akron 1, Ohio

Geo-Optic Co., Inc.
170 Broadway
New York 38, N. Y.

Geophysical Instrument & Supply Co.
1201 Broadway
Denver 2, Colo., page 210

Geophysical Service Inc.
5900 Lemmon Ave.
Dallas, Tex.

Georgia Iron Works Co.
605 12th St.
Augusta, Ga.

Gerber Scientific Instrument Co.
162 State St.
Hartford 1, Conn.

Gering Products, Inc.
N. 7th St., Kenilworth, N. J.

Getman Brothers
U. S. 31
South Haven, Mich.

Giant Grip Mfg. Co.
29 Osceola St.
Oshkosh, Wis.

Giant Mfg. Co.
Sixth St. & 12th Ave.
Council Bluffs, Iowa

Gibraltar Equipment & Mfg. Co.
P. O. Box 304
Alton, Ill.

Gilbreath Chemical Co.
383 Brannan St.
San Francisco, Calif.

Gilmer Co., L. H.
Cottman & Keystone Sts.
Philadelphia 35, Pa.

Gilson Screen Co.
110 Center St.
Malinta, Ohio

Gladden Products Corp.
Box 1191
Glendale 4, Calif.

Globe Forge, Inc.
Syracuse, N. Y.

Godoy & Co., E. A.
25 Broadway
New York 4, N. Y., page 194

Goggle Parts Co.
1468 W. 9th St.
Cleveland 13, Ohio

Goldak Co., Inc.
1544 West Glenoaks Blvd.
Glendale 1, Calif.

Golden-Anderson Valve Specialty Co.
1232 Ridge Ave.
Pittsburgh 33, Pa.

Goodall Brothers
46 S. Main St.
Helena, Mont.

Goodall Rubber Co.
Whitehead Rd.
Trenton, N. J., page 220

Goodman Mfg. Co.
Halsted St. & 48th Place
Chicago 9, Ill.

Goodrich Co., B. F.
Flat Belting
476 Main St.
Akron 11, Ohio

Goodrich Co., B. F.
Truck & Bus Tire Dept.
500 South Main St.
Akron 18, Ohio

Goodrich Industrial Products Co., B. F.
500 S. Main St.
Akron 18, Ohio

Goodyear Tire & Rubber Co.
1144 East Market St.
Akron 16, Ohio

Goodyear Tire & Rubber Co.
Industrial Products
1144 East Market St.
Akron, Ohio

Gorman Rupp Co.
Mansfield, Ohio

Gould Co., Gordon I.
58 Sutter St.
San Francisco 4, Calif., page 247

Gould-National Batteries, Inc.
Trenton 7, N. J.

Goulds Pumps, Inc.
Seneca Falls, N. Y.

Goyne Steam Pump Co
Ashland, Pa.

W. R. Grace & Co.
Hanover Square
New York, N. Y.

Gramm Trailer Corp.
425 E. O'Connor St.
Lima, Ohio

Graton & Knight Co.
356 Franklin St.
Worcester 4, Mass.

Graver Tank & Mfg. Co., Inc.
East Chicago, Ind.

Gray & Co., Inc.
60 11th Ave., N. E.
Minneapolis 13, Minn.

Gray Instrument Co.
200 E. Church Lane
Philadelphia 44, Pa.

Graybar Elec. Co., Inc.
420 Lexington Ave.
New York 17, N. Y.

Great Lakes Electric Mfg. Co.
17 S. Desplaines St.
Chicago 6, Ill.

Green, Inc., R. H.
1201 24th St.
Oakland Calif.

Green Firebrick Co., A. P.
Mexico, Mo.

Greene Tweed Co.
North Wales, Pa.

Greensburg Machinery Co.
Greensburg, Pa.

Gregg Co., Ltd.
241 Main St.
Hackensack, N. J.

Grinnell Co., Inc.
260 West Exchange St.
Providence 1, R. I.

Griphoist, Inc.
424 Bryant St.
San Francisco 9, Calif., page 284

Gruendler Crusher & Pulverizer Co.
2915 North Market St.
St. Louis 6, Mo.

Gulf Oil Corp.
Gulf Refining Co.
1822 Gulf Bldg.
Pittsburgh 30, Pa.

Gulick-Henderson Laboratories, Inc.
25 W. 43rd St.
New York 18, N. Y.

Gunderson-Taylor Machine Co.
1237 Shoshone St.
Denver, Colo.

Gundlach Machine Co., T. J.
Div. of JMJ Industries, Inc.
226 Centreville Ave
Belleville, Ill.

Gurley, W. & L. E.
514 Fulton St.
Troy, N. Y.

Gustin-Bacon Mfg. Co.
210 West Tenth St.
Kansas City, Mo.

Guyan Machy. Co.
755 Stratton Logan, W. Va.

Gwilliam Co.
360 Furman St. Brooklyn 1, N. Y.

H

Haesler Metal & Ore Corp.
11 West 42 Street
New York, N. Y.

Hack Engineering Co.
124 Wazee Market
Denver, Colo.

Hagen Corp.
Hagen Bldg.
Pittsburgh 30, Pa.

Hales Co., W. M.
Box 65
700 Commerce St.
Danville, Ill.

Hall & Sons, Amos H.
9500 N. Water St.
Philadelphia 20, Pa.

Hallett Diesel Engine Div.
American M. A. R. C., Inc.
1601 W. Florence Ave.
Inglewood, Calif.

Hamer Valves, Inc.
P. O. Box 1851
Long Beach 1, Calif.

Hamilton Rubber Mfg. Corp.
Mead St.
Trenton, N. J.

Hammond Co., J. V.
Spangler, Pa., page 198

H. & L. Tooth Co.
1540 South Greenwood Ave.
Montebello, Calif.

Handy & Harman
82 Fulton St.
New York 38, N. Y.

Hanks, Inc., Abbot A.
624 Sacramento St.
San Francisco 11, Calif.

Hanlon & Wilson Co.
325 Pennwood Ave.
Pittsburgh 21, Pa.

Hannon & Sons, F. R.
1605 Waynesburg Rd.
Canton, Ohio

Hapman Conveyors, Inc.
630 Gibson St.
Kalamazoo 6, Mich.

Harbison-Walker Refractories Co.
1800 Farmers Bank Building
Pittsburgh 22, Pa., page 148

Hardinge Co., Inc.
240 Arch St.
York, Pa., page 214

Harnischfeger Corp.
4400 W. National Ave.
Milwaukee 46, Wis., page 156

Harnischfeger Corp.
P & H Diesel Div.
Crystal Lake, Ill.

Harper Electric Furnace Corp.
39 River St.
Buffalo 2, N. Y.

Harrington Co.
Plymouth Meeting, Pa.

Harrington & King Perforating Co.
5655 Fillmore St.
Chicago 44, Ill.

Hartzell Propeller Fan Co.
P. O. Box 909
Piqua, Ohio

Hatheway & Co.
75 Montgomery St.
Jersey City 2, N. J.

Hauck Manufacturing Co.
126 Tenth St.
Brooklyn 15, N. Y.

Hauser-Stander Tank Co.
4820 Spring Grove Ave.
Cincinnati 32, Ohio

Havlick Diamond Drilling Co., Inc.
2703 N. Pittsburg St.
Spokane 26, Wash.

Havlick, J. L.
112 S. Cedar St.
Spokane, Wash.

Hawley & Hawley
Douglas, Ariz.

Hawthorne, Inc., Herb J.
Box 7366
Houston 8, Tex.

Hayward Co.
50 Church St.
New York, N. Y.

Hayes Steel Products, Ltd.
Merritton, Ontario, Canada

Haze Mag-M8H
Munster, Germany, page 180

H-B Instrument Co., Inc.
American & Bristol Sts.
Philadelphia 40, Pa.

Heil Co.
3000 W. Montana
Milwaukee, Wis.

Heiland Div.
Minneapolis Honeywell
5200 E. Evans Ave.
Denver 22, Colo.

Heineken, Inc., W. P.
50 Broad St.
New York, N. Y.

Heinemann Electric Co.
98 Plum St.
Trenton 2, N. J.

Heintz Mfg. Co.
13110 Enterprise Ave.
Cleveland 11, Ohio

Helmick Foundry-Machine Co.
P. O. Box 71
Fairmont, W. Va.

Helwig Co.
2544 N. 30th St.
Milwaukee 10, Wis.

Hendrick Mfg. Co.
Carbondale, Pa.

Hendrickson Mfg. Co.
8001 W. 47th St. Lyons, Ill.

Hendrix Mfg. Co.
Mansfield, La.

Hercules Motors Corp.
101 11th St., S. E.
Canton 2, Ohio

Hercules Powder Co.
Delaware Trust Bldg.
Wilmington, Del.

Hercules Steel Products Corp.
Galion, Ohio

Hertner Electric Co.
12690 Elmwood Ave., N. W.
Cleveland 11, Ohio

Hevi-Duty Electric Co.
4212 W. Highland Blvd.
Milwaukee 1, Wis.

Hewitt Metals Corp.
Stanley Ave. at 12th St.
Detroit 8, Mich.

Hewitt-Robins, Inc.
666 Glenbrook Rd.
Stamford, Conn., page 152

Heyl & Patterson, Inc.
55 Fort Pitt Blvd.
Pittsburgh 22, Pa.

Hill & Jude, Assayers
800 Pearl St. Boulder, Colo.

Hiller Helicopters
1350 Willow Rd.
Palo Alto, Calif., page 224

Hills-McCanna Co.
3025 N. Western Ave.
Chicago 18, Ill.

Hirsch Bros. Machy. Co.
P. O. Box 226
El Paso, Tex.

Hisey-Wolf Machine Co.
Madison & Edwards Rds.
Cincinnati 8, Ohio

Hobart Bros. Co.
Main & Adams St.
Troy 1, Ohio

Hockensmith Corp.
Penn, Pa.

Hoffman Combustion Engineering Co.
Marquette Bldg.
Detroit, Mich.

Hoffman Brothers Drilling & Mfg. Co.
P. O. Box 426
Punxsutawney, Pa., pag 286

Holman Bros. (Canada), Ltd.
97 Kent Ave.
Kitchener, Ontario, Canada

Holman Bros., Ltd.
Camborne,
Cornwall, England

Holmes & Bros., Inc., Robert
570 Junction Ave.
Danville, Ill.

Holtite Mfg. Co.
Warner & Ostend Sts.
Baltimore 30, Md.

Homelite Corp.
75 Riverdale Ave.
Port Chester, N. Y.

Homer Mfg. Co.
Lima, Ohio

Homestead Valve Mfg. Co.
P. O. Box 348
Coraopolis, Pa.

Hose Accessories Co.
17th St. & Lehigh Ave.
Philadelphia 32, Pa.

Hose-McCann Telephone Co.
25th St. & Third Ave.
Brooklyn 32, N. Y.

Hoskins Mfg. Co.
4447 Lawton Ave.
Detroit 8, Mich.

Hossfeld Mfg. Co.
Winona, Minn., page 247

Hough Co., Frank G.
737 Fairview Ave.
Libertyville, Ill.

Houghton & Co., E. F.
303 W. Lehigh Ave.
Philadelphia 33, Pa.

House & Sons, Inc., Chas. W.
Unionville, Conn.

Houston Technical Laboratories
2424 Branard
Houston 6, Tex.

Houston Tool Co., Inc.
P. O. Box 251
Santa Susana, Calif., page 194

Howe Scale Co., Inc.
Rutland, Vt.

Howell Electric Motors Co.
Howell, Mich.

Howells Mining Drill Co.
Plymouth, Pa.

Hoyland Steel Co.
5104 Chrysler Bldg.
405 Lexington Ave.
New York, N. Y.

Hoyt Wire Cloth Co.
Box 22
Lancaster, Pa.

Hudson Engineering Corp.
2711 Danville
Houston, Tex.

Hughes Tool Co.
300 Hughes
Houston, Tex.

Hulburt Oil & Grease Co.
Trenton & Castor Aves.
Philadelphia 34, Pa.

Humphreys Investment Co.
Engineering Div.
915 First National Bank Bldg.
Denver 2, Colo., page 229

Hunt & Son, Inc., C. B.
Salem Ohio

Hycon Aerial Surveys, Inc.
1020 S. Arroyo Pkwy.
Pasadena 13, Calif.

Hydraulic Supply Mfg. Co.
7500 Eighth Ave. So.
Seattle, Wash.

Hypro Engineering, Inc.
700 39 Ave., N. E.
Minneapolis 21, Minn.

Hyster Co.
2965 N. E. Clackamas St.
Box 4318
Portland 8, Ore.

I

Ideal Electrical & Mfg. Co.
Mansfield, Ohio

Ideal Industries, Inc.
1020 Park Ave.
Sycamore, Ill.

Ilg Electric Ventilating Co.
2850 N. Pulaski Rd.
Chicago 41, Ill.

Illinois Iron & Bolt Co.
1932 Thomas St.
Carpentersville, Ill.

Illinois Powder Mfg. Co.
506 Olive St.
St. Louis 1, Mo.

Illinois Testing Laboratories, Inc.
420 N. La Salle St.
Chicago 10, Ill.

Illinois Zinc Co.
2959 W. 47th St.
Chicago 32, Ill.

Imperial-Cantrell Mfg. Co.
P. O. Box 538
Jellico, Tenn.

Imperial Electric Co.
63 Ira Ave.
Akron 9, Ohio

Indiana Commercial Filters Corp.
215 Wabash Ave.
Lebanon, Ind.

Indiana Foundry Co.
Indiana, Pa.

Indiana Oxygen Co.
435 S. Delaware St.
Indianapolis 25, Ind.

Industrial Air Products Co.
3200 N. W. Yeon Ave.
Portland, Ore.

Industrial Brownhoist Corp.
Bay City Mich.

Industrial Engrg. & Construction Co.
First National Bank Bldg.
Fairmont, W. Va.

Industrial Gloves Co.
700 Garfield St.
Danville, Ill.

Industrial Metal Protectives, Inc.
401 Homestead Ave.
Dayton 8, Ohio

Industrial Overlay Metals, Inc.
410 N. Barron St.
Eaton, Ohio

Industrial Oil Products Corp.
Margaret and Pearce
Philadelphia, Pa.

Industrial Physics & Electronics Co.
470 South Tenth East St.
Salt Lake City 2, Utah

Industrial Sales Div.
Remington Arms Co., Inc.
Barnum Ave.
Bridgeport 12, Conn.

Infilco, Inc.
901 S. Campbell Ave.
Tucson, Ariz.

Ingersoll-Rand Co.
Phillipsburg, N. J., pages 3, 190

Inland Steel Co.
38 S. Dearborn St.
Chicago 3, Ill.

Inland Steel Products Co.
4101 W. Burnham St.
Milwaukee 1, Wis.

Insley Manufacturing Corp.
801 N. Olney St.
Indianapolis 6, Ind.

Insul-Mastic Corp. of America
7750 W. 61st Place
Summit, Ill.

International Business Machine Corp.
590 Madison Ave.
New York 22, N. Y.

International General Electric Co.
570 Lexington Ave.
New York 22, N. Y.

International Harvester Co.
Motor Truck Div.
180 North Michigan Ave.
Chicago 1, Ill.

International Harvester Co.
Ind. Power Div.
North & La Grange Sts.
Melrose Park, Ill.

International Harvester Export Co.
180 No. Michigan Ave.
Chicago 1, Ill., opp. p. 146

International Nickel Co.
67 Wall St., New York 5, N. Y.

International Minerals & Metals Corp.
11 Broadway
New York 4, N. Y., page 230

International Paper Co.
220 E. 42nd St.
New York 17, N. Y.

International Resistance Co.
401 N. Broad St.
Philadelphia 8, Pa.

International Salt Co.
Scranton 2, Pa.

International Shoe Co.
1509 Washington Ave.
St. Louis 3, Mo.

Interstate Drop Forge Co.
4051 27th St., Milwaukee, Wis.

Ionics, Inc.
152 Sixth St.
Cambridge 42, Mass.

Iowa Mfg. Co.
916 16th St., N. E.
Cedar Rapids, Iowa, page 181

Ironton Engine Co.
Farmingdale, N. J.

Ironton Fire Brick Co.
Ironton, Ohio

Irving Subway Grating Co., Inc.
50-14 27th St.
Long Island City 1, N. Y.

Irvington Varnish & Insulator Div.
Minnesota Mining & Mfg. Co.
6 Argyle Terrace
Irvington 11, N. J.

Irwin Foundry & Mine Car Co.
Box 311, Irwin, Pa.

I-T-E Circuit Breaker Co.
19th & Hamilton Sts.
Philadelphia 30, Pa.

J

Jacuzzi Bros., Inc.
Richmond, Calif.

Jaeger Machine Co.
550 W. Spring St.
Columbus 16, Ohio

Jarrell-Ash Co.
26 Farwell St.
Newtonville 60, Mass., page 249

Jeb Instruments Co.
4641 Hollywood Blvd.
Los Angeles 27, Calif.

Jefferson Union Co.
601 W. 26th St.
New York 1, N. Y.

Jeffrey Mfg. Co.
962 N. Fourth St.
Columbus 16, Ohio

Jenkins Bros.
100 Park Ave., New York 17, N. Y.

Jesco Lubricants Co.
P. O. Box 7331
Kansas City 16, Mo.

Jessop Steel Co.
538 Green St.
Washington, Pa.

Jet-Lube, Inc.
3093 North California St.
Burbank, Calif.

Johns-Manville
22 E. 40th St.
New York 16, N. Y.

Johnson Co., C. S.
Champaign, Ill.

Johnson Co., R. G.
831 Wash. Trust Bldg.
Washington, Pa.

Johnson Corp.
816 Wood St.
Three Rivers, Mich.

Johnson Belting Co.
44 Hubert St.
New York 13, N. Y.

Johnson Bronze Co.
492 S. Mill St.
New Castle, Pa.

Johnson Loading Supplies, G. R.
5026 Butterworth Rd.
Mercer Island, Wash.

Johnson Machine Co., Carlyle
52 Main St.
Manchester, Conn.

Johnson Mfg. Co., Inc.
Fox Ave. & Holly St.
Seattle 8, Wash.

Johnson-March Corp.
1724 Chestnut St.
Philadelphia 3, Pa.

Johnson Plastic Corp.
201 Brown Rd.
Chagrin Falls, Ohio

Johnston-Morehouse-Dickey Co.
704 Second Ave.
Pittsburgh 19, Pa.

Johnston Pump Co.
3272 E. Foothill Blvd.
Pasadena 8, Calif.

Jones & Laughlin Steel Corp.
3 Gateway Center
Pittsburgh 30, Pa., pages 203, 204

Jones Foundry & Machine Co., W. A.
4401 W. Roosevelt Road
Chicago 24, Ill.

Joy Mfg. Co.
Henry W. Oliver Bldg.
Pittsburgh 22, Pa., page 154

Joyce-Cridland Co.
2027 E. First St.
Dayton, Ohio

Judd & Son, J. D.
Shullsburg, Wis.

Judsen Rubber Works, Inc.
4107 West Kinzie St.
Chicago 24, Ill.

Justrite Mfg. Co.
2061 Southport Ave.
Chicago 14, Ill.

K

Kaiser Aluminum & Chemical Sales, Inc.
1924 Broadway
Oakland 12, Calif.

Kaiser Engineers
1924 Broadway
Oakland, Calif.

Kanawha Mfg. Co.
1520 Dixie St.
Charleston 1, W. Va.

Kato Engineering Co.
Mankato Minn.

Kaydon Engineering Corp.
Muskegon, Mich.

Keasbey & Mattison Co.
Ambler, Pa.

Keeler Co., E.
238 West St.
Williamsport 3, Pa.

Keeney Co., Paul E.
1125 S. E. Grand Ave.
Portland 14, Ore.

Kellems Co.
15 Williams St.
Stonington, Conn.

Kellogg Co., M. W.
711 Third Ave.
New York 17, N. Y.

Kennametal Inc.
Latrobe, Pa., page 241

Kennedy Valve Mfg. Co.
Elmira, N. Y.

Kennedy-Van Saun Mfg. & Eng. Corp.
2 Park Ave.
New York, N. Y., page 157

Ken Research, Inc.
681 Main St.
Hackensack 1, N. J.

Kensington Steel Co.
505 Kensington Ave.
Chicago 28, Ill.

Kenworth Motor Truck Corp.
8801 E. Marginal Way
Seattle 11, Wash.

Kenyon Walker Machinery Co.
1600 11th St.
Denver 2, Colo.

Kerite Co.
30 Church St.
New York 7, N. Y.

Kerlow Steel Flooring Co.
222 Culver Ave.
Jersey City 5, N. J.

Kern Instruments, Inc.
120 Grand St.
White Plains, N. Y., page 232

Kerrigan Iron Works, Inc.
1033 Herman St.
Nashville 2, Tenn.

Kersey Mfg. Co., Inc.
P. O. Box 151
Bluefield, Va.

Keuffel & Esser Co.
300 Adams St.
Hoboken, N. J.

Kewanee-Ross Corp.
1407 West Ave.
Buffalo 13, N. Y.

Keystone Carbon Co.
State Street
St. Marys, Pa.

Keystone Lubricating Co.
21st & Clearfield Sts.
Philadelphia 32, Pa.

Kidde & Co., Inc., Walter
956 Main St.
Belleville 9, N. J.

Kieley & Mueller, Inc.
64 Gemung St.
Middletown, N. Y.

Kilby V. Claiborne
Milton, N. C.

Killark Electric Mfg. Co.
3940 Easton Ave.
St. Louis, Mo.

King Powder Co.
1703 First National Bank Bldg.
Cincinnati 2, Ohio

Kirk & Blum Mfg. Co.
3150 Forrer St.
Cincinnati 9, Ohio

Klein & Sons, Mathias
7200 McCormick Rd.
Chicago 45, Ill.

Klemp Metal Grating Corp.
6613 S. Melvina Ave.
Chicago 38, Ill.

Klipfel Valves, Inc.
1075 Lincoln Ave.
Hamilton, Ohio

Klockner-Humboldt-Deutz Ag.
c/o Diesel Energy Corp.
82 Beaver St.
New York 5, N. Y.

Knapp Mills, Inc.
2315 Borden Ave.
Long Island City, N. Y.

Knopp Inc.
4224 Holden St.
Oakland 8, Calif.

Knox Mfg. Co.
222 W. Clinton St.
Oaklyn, N. J.

Kobe, Inc.
3040 E. Slauson Ave.
Huntington Park, Calif.

Koebel Diamond Tool Co.
9456 Grinnell
Detroit 13, Mich.

Koehring Co.
31st & Concordia Ave.
Milwaukee 16, Wis.

Kolton Electric Mfg. Co.
123 New Jersey R. R. Ave.
Newark 5, N. J.

Komline-Sanderson Engineering Corp.
Peapack, N. J.

Koppers Co., Inc.
Koppers Bldg., Pittsburgh 19, Pa.

Koppers Co., Inc.
Metal Prod. Div.
200 Scott St., Baltimore 30, Md.

Korb-Pettit Wire Fabrics & Iron Works
1501-15 N. Mascher St.
Philadelphia 22, Pa.

Kraft Bag Corp.
630 Fifth Ave.
New York, N. Y.

Kremser & Sons, Inc., Frank A.
3435 N. Fifth St.
Philadelphia, Pa.

Krogh Pump & Equipment Co.
515 Harrison St.
San Francisco, Calif.

Kuhlman Electric Co.
26th & Jefferson Sts.
Bay City, Mich.

Kurz & Root Co.
232 E. North Island St.
Appleton, Wis.

K. W. Battery Co.
3555 Howard St.
Skokie, Ill.

L

LaBour Co.
1607 Sterling Ave.
Elkhart Ind.

Laclede-Christy Co., Div.
H. K. Porter Co., Inc.
2000 Hampton Ave.
St. Louis 10, Mo.

LaCrosse Trailer Corp.
La Crosse, Wis.

Ladish Co.
Cudahy, Wis.

Lake Shore, Inc.
Lake Shore Engineering Div.
Iron Mountain, Mich.

Lakeside Bridge & Steel Co.
5300 N. 33rd St.
Milwaukee 9, Wis.

Lamson Corp.
210 Lamson St.
Syracuse 1, N. Y.

Lumson & Sessions Co.
1971 West 85th St.
Cleveland 2, Ohio

Lancaster Pump & Mfg. Co.
Lancaster, Pa.

Landis Steel Co.
116 West A St., Box 248
Picher, Okla.

La Roe Instruments, Inc.
Box 5906
Bethesda 14, Md., page 228

Lattimer Foundry & Machine Co.
Lattimer Mines, Pa.

Laubenstein Mfg. Co.
422 S. Third St.
Ashland, Pa.

Laughlin Co., Div.
American Hoist & Derrick Co.
143 Fore St.
Portland 6, Me.

Lawrence Pumps, Inc.
371 Market St.
Lawrence, Mass.

Laylander, Philip A.
Box 241
Fallon, Nev.

Layne & Bowler Pump Co. of Los Angeles
2943 South Vail Ave.
Los Angeles 22, Calif.

Layne & Bowler, Inc.
1993 Chelsea Ave.
Memphis 8, Tenn.

Leach Corp.
Palmer Electric Mfg. Co. Div.
4443 Santa Fe Ave.
Los Angeles 58, Calif.

Leavitt Machine Co.
Orange, Mass.

Lebanon Steel Foundry
Lebanon, Pa.

Le Bus Rotary Tool Works
Longview, Tex.

Lecco Machinery & Engineering Co.
Box 3036
Bluefield, W. Va.

Lecourtenay Co.
5 Maine St.
Newark 5, N. J.

Lectromelt Furnace Co. Div.
McGraw Electric Co.
P. O. Box 1257
Pittsburgh 30, Pa.

Ledeen Mfg. Co.
1600 South San Pedro St.
Los Angeles 15, Calif.

Ledoux & Co.
359 Alfred Ave.
Teaneck, N. J., page 228

Lee-Norse Co.
Charleroi, Pa.

Leeds & Northrup Co.
4970 Stenton Ave.
Philadelphia 44, Pa.

Leetonia Tool Co.
142 Main St.
Leetonia, Ohio

Leffel & Co., James
426 East St.
Springfield, Ohio

Lehigh Safety Shoe Co.
First & Minor Sts.
Emmaus, Pa.

Leland Electric Div.
American Machine & Foundry Co.
1501 Webster St.
Dayton 1, Ohio

Le Roi Div.
Westinghouse Air Brake Co.
Milwaukee 1, Wis.

Leschen Wire Rope Div.
H. K. Porter Co., Inc.
2727 Hamilton Ave.
St. Louis 12, Mo.

Le Tourneau-Westinghouse Co.
P. O. Box 240
Peoria, Ill., pages 169, 171

Leupold & Stevens Instruments, Inc.
4445 N. E. Glisan St.
Portland 13, Ore.

Levantementos Aerofotogrammhetricos, S. A.
Rua da Alfrandega
107-1.o Andar,
Rio de Janeiro, Brazil

Lewellen Mfg. Co.
10th St. & Werner Ave.
Columbus, Ind.

Lewis Bolt & Nut Co.
504 Malcolm Ave., S. E.
Minneapolis 14, Minn.

Lidgerwood Industries, Inc.
7 Dey St.
New York, N. Y.

Lilie-Hoffman Cooling Towers, Inc.
1450 So. Vandeventer
St. Louis 10, Mo.

Lima Electric Motor Co.
Findlay Rd.
Lima, Ohio

Linatex Corp. of America
Rockville, Conn., page 236

Lincoln Electric Co.
22801 St. Clair Ave.
Cleveland 17, Ohio

Lincoln Engineering Co.
5701 Natural Bridge
St. Louis 20, Mo.

Line Material Co.
700 W. Michigan St.
Milwaukee 1, Wis.

Link-Belt Co.
Prudential Plaza
Chicago 1, Ill., pages 14, 15

Link-Belt Speeder Corp.
1201 6th St., S. W.
Cedar Rapids, Iowa

Lippmann Engineering Works
4603 W. Mitchell St.
Milwaukee, Wis., page 184

Lister-Blackstone, Inc.
420 Lexington Ave.
New York 17 16, N. Y.

Little Giant Crane & Shovel Co.
Des Moines 13, Iowa

Lockrey Co.
Southampton, N. Y.

Logan Engineering Co.
4901 W. Lawrence Ave.
Chicago 30, Ill., page 237

Lombard Governor Corp.
Main St.
Ashland, Mass.

Lonergan Co., J. E.
Second & Race Sts.
Philadelphia 6, Pa.

Long Co.
Box 331
Oak Hill, W. Va.

Longyear Co., E. J.
1700 Foshay Tower
Minneapolis 2, Minn.

Los Angeles Steel Casting Co.
6100 South Boyle
Los Angeles 58, Calif.

Louden Machinery Co.
607 Broadway, Fairfield, Iowa

Lovejoy Flexible Coupling Co.
4835 W. Lake St., Chicago 44, Ill.

Ludlow-Saylor Wire Cloth Co.
634 S. Newstead
St. Louis 10, Mo.

Lufkin Rule Co.
1730 Hess Ave.
Saginaw, Mich.

Lug-All Co.
355 Lancaster Ave.
Haverford, Pa.

Lukens Steel Co.
Coatesville, Pa.

Lumen Bearing Co.
197 Lathrop St.
Buffalo 12, N. Y.

Lundberg Explorations, Ltd.
80 Richmond West
Toronto, Ontario Canada

Lunkenheimer Co.
Beekman St. & Waverly Ave.
Cincinnati 14, Ohio

Luzerne Rubber Co.
Muirhead & Dewey Sts.
Trenton 7, N. J.

M

Macbeth Daylighting Corp.
Newburgh, N. Y.

MacClatchie Mfg. Co.
Compton, Calif.

Mace Co.
2763 Blake St.
Denver 5, Colo., page 248

Machinery Center, Inc.
Salt Lake City, Utah, page 286

Mack Trucks, Inc.
1355 West Front St.
Plainfield, N. J.

Macklin Co.
1936 Lawrence Blvd.
Jackson, Mich.

MacLeod Co.
Box 452, Sharonville, Ohio

Macklin Equipment Co.
520 Harbor Blvd., P. O. Box 535
W. Sacramento, Calif.

Macmillan Petroleum Corp.
530 W. Sixth St.
Los Angeles 14, Calif.

Macwhyte Co.
2937 14th Ave.
Kenosha, Wis.

Maddox Foundry & Machine Works, Inc.
Archer, Fla.

Madesco Tackle Block Co.
Easton, Pa.

Magnetic Engineering & Mfg. Co.
852 Van Houten Ave.
Clifton, N. J.

Magnolia Metal Co.
18 W. Jersey St.
Elizabeth 4, N. J.

Magor Car Corp.
50 Church St.
New York 7, N. Y.

Magnus, Inc., W. R.
188 West Randolf St.
Chicago, Ill.

Mahogany Importing Co.
725 South Spring St.
Los Angeles 14, Calif.

Mahon Co., R. C.
P. O. Box 4666
Detroit 34, Mich.

Mahr Mfg. Co.
Minneapolis 23, Minn.

Majac Inc.
23rd St., Sharpsburg 15, Pa.

Malleable Iron Fittings Co.
Maple St.
Grandford, Conn.

Mallinckrodt Chemical Works
2nd & Mallinckrodt Sts.
St. Louis 7, Mo.

Mancha Storage Battery Locomotive Div.
Goodman Mfg. Co.
Halsted St. & 48th Pl.
Chicago 9, Ill.

M & M Woodworking Co.
National Tank & Pipe Div.
2301 North Columbia Blvd.
Portland, Ore.

Manganese Steel Forge Co.
Allen St. & Castor Ave.
Philadelphia 34, Pa.

Manheim Mfg. & Belting Co.
370 Striegel St., Manheim, Pa.

Manitowoc Engineering Corp.
South 16th St., Manitowoc, Wis.

Manitoba Steel Foundries, Ltd.
Selkirk, Manitoba, Canada

Manning, Maxwell & Moore, Inc.
Shaw Box Crane & Hoist Div.
Muskegon, Mich.

Manu-Mine Research & Devel. Co.
P. O. Box 167
Reading, Pa.

Manzel Div.
Houdaille Industries, Inc.
315 Babcock St.
Buffalo 10, N. Y.

Marathon Coal Bit Co.
Montgomery W. Va.

Marathon Corp.
Chemical Div.
Box 557
Rothschild, Wis.

Marathon Electric Mfg. Corp.
Wausau, Wis.

Marble Card Electric Corp.
Superior St.
Gladstone, Mich.

Marion Metal Products Co.
Cheney Ave.
Marion Ohio

Marion Power Shovel Co.
Marion, Ohio

Markley Dust Control System, Inc.
80 Snyder Rd.
Ramsey, N. J.

Marland One-Way Clutch Co.
561 Hillgrove Ave.
La Grange, Ill.

Marley Co.
222 West Gregory Blvd.
Kansas City 14, Mo.

Marlin-Rockwell Corp.
402 Chandler St.
Jamestown, N. Y.

Marlow Pumps
Box 200
Midland Park, N. J.

Marmon-Harrington Co.
1511 W. Washington St.
Indianapolis 7, Ind.

Marquette Mfg. Co., Inc.
307 E. Hennepin Ave.
Minneapolis 14, Minn.

Marsh Engineering Co., E. F.
4324 W. Clayton Ave.
St. Louis 10, Mo.

Martin Engineering Co.
Neponset, Ill.

Martin Fan & Blower Co.
4634 W. 21st Pl.
Chicago 50, Ill.

Marvel Engineering Co.
7227 N. Hamlin Ave.
Chicago 45, Ill.

Maryland Bolt & Nut Co.
Mt. Washington
Baltimore 9, Md.

Maschinenfabrik Rudolf Hausherr & Soehne, GmbH
c/o B. J. Nykerk Corp.
42 Broadway
New York 4, N. Y.

Massachusetts Gear & Tool Co.
30 Nashua St.
Woburn, Mass.

Master Builders Co.
7016 Euclid Ave.
Cleveland 3, Ohio

Master Bronze Powder Co.
5009 Calumet Ave.
Hammond, Ind.

Master Electric Co.
126 Davis Ave.
Dayton 1, Ohio

Master Mfg. Co.
Hutchinson, Kan.

Matheson Co., Inc.
932 Paterson Plank Rd.
East Rutherford, N. J.

Mathews Conveyor Co.
198 10th St.
Ellwood City, Pa.

Mavor & Coulson, Ltd.
Bridgeton, Glasgow, S. E.
Scotland

Maxi Corp.
P. O. Box 3129, Terminal Annex
Los Angeles 54 Calif.

Mayhew Machine & Supply Co.
P. O. Box 7726
Dallas, Tex.

Maxon Construction Co.
131 N. Ludlow St.
Dayton, Ohio

Mayo Tunnel & Mine Equipment Co.
Box 1413
Lancaster, Pa.

McCabe-Powers Auto Body Co.
5900 Block N. Broadway
St. Louis 15, Mo.

McClintock Co., R. S.
W. 418 Second Ave.
Spokane, Wash.

McCord Corp.
E. Grand Blvd. & Riopelle Sts.
Detroit 11, Mich.

McCulloch Motors Corp.
6101 West Century Blvd.
Los Angeles 45, Calif.

McDonald Drilling Co., Inc.
14408 St. Marys Ave.
Detroit 27, Mich.

McDonald Mfg. Co., A. Y.
12th & Pine Sts.
Dubuque, Iowa

McDowell Co.
Dwight-Lloyd Div.
16300 Waterloo Rd.
Cleveland 10, Ohio

McFarlane-Eggers Machinery Co.
2763 Blake St.
Denver, Colo.

McGill Mfg. Co., Inc.
1151 N. Lafayette St.
Valparaiso, Ind.

McGowan Pump Div.
Leyman Mfg. Corp.
58 Central Ave.
Cincinnati 2, Ohio

McGraw & Co., F. H.
51 East 42nd St.
New York, N. Y.

McKay Co.
York, Pa.

McKee & Co., Arthur G.
2300 Chester Ave.
Cleveland, Ohio

McKiernan-Terry Corp.
505 Manor Ave.
Harrison, N. J.

McKinney Drilling Co.
P. O. Box 190
Nacogdoches, Tex.

McLanahan & Stone Corp.
Hollidaysburg, Pa.

McMillan's Sons, W. H.
49 South St.
New York, N. Y.

McNally Pittsburg Mfg. Corp.
307 W. Third St.
Pittsburg, Kan.

McPhar Geophysics, Ltd.
139 Bond Ave.
Don Mills, Ontario, Canada

McPhar Manufacturing, Ltd.
139 Bond Ave.
Don Mills, Ontario, Canada

Mead Mill Co.
20225 Mack Ave.
Detroit 36, Mich.

Mechanical Industries, Inc.
541 Wood St.
Pittsburgh 22, Pa.

Meckum Engineering, Inc.
53 W. Jackson Blvd.
Chicago 3, Ill.

Medart Co.
1 Potomac St.
St. Louis 18, Mo.

Meehanite Metal Corp.
714 North Ave.
New Rochelle, N. Y.

Meeker Foundry Co.
95 Clay St.
Newark 4, N. J.

Memco Engineering & Mfg. Co.
Commack, N. Y.

Menlo Research Laboratory
P. O. Box 522
Menlo Park, Calif.

Merck & Co.
Rahway, N. J.

Merco Nordstrom Valve Co.
400 Lexington Ave.
Pittsburgh, Pa.

Meriam Instrument Co.
10920 Madison Ave.
Cleveland 2, Ohio

Merrick Scale Mfg. Co.
184 Autumn St.
Passaic, N. J., page 212

Metal & Thermite Corp.
100 E. 42nd St.
New York, N. Y.

Metal Carbides Corp.
107 E. Indianola Ave.
Youngstown 7, Ohio

Metal Traders Inc.
67 Wall St., New York, N. Y.

Metallizing Engineering Co., Inc.
1101 Prospect Ave.
Westbury, N. Y.

Metallo Gasket Co.
12 Bethany St.
New Brunswick, N. J.

Metals Disintegrating Co., Inc.
Pulverizing Machinery Div.
Chatham Rd.
Summit, N. J.

Metron Instrument Co.
432 Lincoln St.
Denver, Colo.

Mexico Refractories Co.
Mexico, Mo.

Michigan Pipe Co.
6581 Mill St.
Gagetown, Mich.

Michinan Power Shovel Co.
Benton Harbor, Mich.

Michigan-Standard Alloy Casting Co.
1999 Guoin St.
Detroit 7, Mich.

Micro Switch Div.
Minneapolis-Honeywell Regulator Co.
Freeport, Ill.

Midvale-Heppenstall
4301 Wissahickon Ave.
Philadelphia 40, Pa.

Midwest Carbide Corp.
Empire State Bldg.
New York 1, N. Y.

Miehle Printing Press & Mfg. Co.
Star-Kimble Motor Div.
200 Bloomfield Ave.
Bloomfield, N. J.

Mill & Mine Supply, Inc.
625 Lander St.
Seattle 4, Wash.

Miller Electric Mfg. Co., Inc.
Box 798
Appleton, Wis.

Milwaukee Electric Tool Corp.
5316 W. State St.
Milwaukee 8, Wis.

Mine & Smelter Supply Co.
Marcy Mill Div.
P. O. Box 5270, Terminal Annex
Denver 17, Colo., page 186

Mine Safety Appliances Co.
201 North Braddock Avenue
Pittsburgh 21, Pa., page 284

Minerais et Metaux
55 Rue D'Amsterdam
Paris 8, France

Minerals Engineering Co.
801 Fourth Ave.
Grand Junction, Colo., page 249

Minerals Exploration & Research Corp.
2120 Ford St.
Golden, Colo.

Minerals Laboratory
1303 Grant St.
Silver City, N. M.

Minerec Corp.
120 Broadway
New York, N. Y.

Miners Foundry & Mfg. Co.
200 Spring St.
Nevada City, Calif.

Miner's Hardware Supply Co.
523 Brushton Ave.
Pittsburgh 21, Pa., page 284

Mining Machine Parts, Inc.
5702 St. Clair Ave.
Cleveland 8, Ohio

Minneapolis-Honeywell Regulator Co.
2753 Fourth Ave., S.
Minneapolis 8, Minn.

Minneapolis-Honeywell Regulator Co.
Industrial Div.
Wayne & Windrim Aves.
Philadelphia 44, Pa.

Minnesota Mining & Mfg. Co.
900 Fauquier St.
St. Paul 6, Minn.

Mission Mfg. Co., P. O. Box 4209
Houston, Tex.

Missouri Belting Co.
1029 S. Grand Blvd., St. Louis 4, Mo.

Mitchell Mfg. Co.
101 Sherman Ave.
New York 34, N. Y.

Mobile Drilling, Inc.
960 N. Pennsylvania St.
Indianapolis 4, Ind.

Moloney Electric Co.
5390 Bircher Blvd.
St. Louis 20, Mo.

Monsanto Chemical Co.
1700 South 2nd St., St. Louis 4, Mo.

Moore Co.
800 South Missouri St.
Marceline, Mo.

Moore Co.
1036 Quarrier St.
Charleston, W. Va.

Moore Drop Forging Co.
38 Walter St.
Springfield 7, Mass.

Moore & Siegal
Shullsburg, Wis.

Morris Machine Works
Baldwinsville, N. Y.

Morse Bros. Machinery Co.
P. O. Box 1708
Denver, Colo., page 245

Morse Chain Co.
7601 Central Ave.
Detroit 10, Mich.

Morton Salt Co.
120 S. LaSalle St.
Chicago 3, Ill.

Motorola Communications & Electronics, Inc.
4501 Augusta Blvd.
Chicago 51, Ill.

Mott Core Drilling Co.
830 Eighth Ave.
Huntington 17, W. Va.

Mt. Sopris Instrument Co.
1320 Pearl St.
Boulder, Colo.

Mt. Vernon-Woodberry Mills, Inc.
Mercantile Trust Bldg.
Baltimore 2, Md.

Mueller Brass Co.
1925 Lapeer Ave.
Port Huron, Mich.

Muller & Co., Inc., Wm. H.
122 East 42nd St.
New York, N. Y.

Mullite Refractories Co.
Canal St., Shelton, Conn...

Multi Electrical Mfg. Co.
4243 W. Lake St.
Chicago 24, Ill.

Murphy Diesel Co.
5317 W. Burnham St.
Milwaukee 11, Wis.

Murphy, F. M.
1201 Maryland Parkway
Las Vegas, Nev.

Murray Iron Works Co.
1106 Washington St.
Burlington, Iowa

Myers-Whaley Co., Inc.
P. O. Box 789
Louisville 9, Ky., page 284

N

Nachod & U. S. Signal Co.
4777 Louisville Ave.
Louisville 9, Ky., page 284

Nagle Pumps, Inc.
1249 Center St.
Chicago Heights, Ill., page 246

Napco Industries, Inc.
834 North Seventh St.
Minneapolis 11, Minn.

Nash Engineering Co.
218 Wilson Rd.
South Norwalk, Conn.

Nathan Mfg. Co.
45-02 Ditmars Blvd.
Long Island City 5, N. Y.

National Aluminate Corp.
6216 West 66th Place
Chicago 38, Ill.

National Automotive Fibres, Inc.
Railroad Ave. & Kennedy St.
Oakland, Calif.

Tube Turn Div.
National Cylinder Gas Co.
840 N. Michigan Ave.
Chicago 11, Ill.

National Electric Coil Co.
Columbus 16, Ohio

National Electric Products Corp.
Gateway Center
140 Stanwix St.
Pittsburgh 22, Pa.

National Filter Media Corp.
1717 Dixwell Ave.
New Haven 11, Conn.

National Fuse & Powder Co.
3801 Delgany St.
Denver 5, Colo.

National Iron Co.
Ramsey St. & 50th Ave. W.
Duluth 7, Minn., p. 230

National Lead Co.
111 Broadway
New York 6, N. Y.

National Malleable & Steel Castings Co.
10606 Quincy Ave.
Cleveland 6, Ohio, p. 193

National Mine Service Co.
Suite 564 Alcoa Bldg.
Pittsburgh 19, Pa.

National Motor Bearings
Arrowhead Rubber Co. Div.
2350 Curry St.
Long Beach 5, Calif.

National Powder Co.
Eldred, Pa.

National Production Co.
4561 St. Jean Ave.
Detroit 13, Mich.

National Safety Council
425 N. Michigan Ave.,
Chicago 11, Ill.

National Supply Co.
No. 2 Gateway Center
Pittsburgh, Pa.

National Tank & Pipe Co.
2301 N. Columbia Blvd.
Portland 3, Ore.

National Vulcanized Fibre Co.
Wilmington, Del.

Naylor Pipe Co.
1243 E. 92nd St.
Chicago 19, Ill., p. 192

Neal Machinery Co., H. T.
57 Post St.
San Francisco, Calif.

Neff & Fry Co.
Camden, Ohio

Newage International, Inc.
222 York Rd.
Jenkintown, Pa.

Newark Wire Cloth Co.
370 Verona Ave.
Newark 4, N. J.

Newcomer Products Inc.
Latrobe, Pa.

New Era Engineering Co.
458 West 29 St.
Chicago 16, Ill.

Newhall Chain Forge & Iron Co.
11 Orchard Rd.
Park Ridge, N. J.

New Jersey Meter Co.
Plainfield, N. J.

New Jersey Zinc Co.
160 Front St.
New York 7, N. Y.

New Mexico Minerals Laboratory
1303 Grant St.
Silver City, N. M.

Newport Industries, Inc.
230 Park Ave.
New York, N. Y.

New York Air Brake Co.
230 Park Ave.
New York 17, N. Y.

New York Air Brake Co.
Aurora Pump Div.
86 Loucks St.
Aurora, Ill.

New York Air Brake Co.
Hydraulic Div.
230 Park Ave.
New York 17, N. Y.

New York Belting & Packing Co.
1 Market St.
Passaic, N. J.

New York Engineering Co.
75 West St.
New York 6, N. Y.

New York Rubber Corp.
100 Park Ave.
New York 17, N. Y.

New York &
New Jersey Lubricant Co.
292 Madison Ave.
New York 17, N. Y.

Newhall Chain Forge & Iron Co.
11 Orchard Rd.
Park Ridge, N. J.

Nice Ball Bearing Co.
30th & Hunting Park Ave.
Philadelphia 40 Pa.

Nichols Engineering &
Research Corp.
70 Pine St.
New York 5, N. Y.

Nicholson & Co., W. H.
12 Oregon St.
Wilkes-Barre, Pa.

Nife, Inc.
Lambert Ave.
Copiague, N. Y.

Nolan Co.
120 Pennsylvania St.
Bowerston, Ohio

Nordberg Mfg. Co.
3073 S. Chase Ave.
Milwaukee 1, Wis., p. 188

Norden-Ketay Corp.
Milford, Conn.

Norma-Hoffman Bearings Corp.
Stamford, Conn.

North American Phillips Co.
100 E. 42nd St.
New York 17, N. Y.

North American Refractories Co.
E. 6th at Euclid Ave.
Cleveland 14, Ohio

Northern Blower Co.
6410 Barberton Ave.
Cleveland, Ohio, p. 212

Northern Conveyor Co.
P. O. Box 46
Janesville, Wis.

Northwest Engineering Co.
135 S. La Salle St.
Chicago 3, Ill.

Northwest Steel Rolling Mills
4315 9th Ave., N.W.
Seattle 7, Wash.

Northwestern Electric Co.
1750 N. Springfield Ave.
Chicago 47, Ill.

Norton Co.
1 New Bond St.
Worcester 6, Mass.

Novo Pump & Engine Co.
702 Porter St.
Lansing 5, Mich.

Nuclear Exploration Co.
826 East 7th St.
Los Angeles 21, Calif.

Nuclear Instrument &
Chemical Corp.
223 W. Erie St.
Chicago, Ill.

Nuclear Instrument &
Chemical Corp.
2235 South La Brea St.
Los Angeles 16, Calif.

Nuclear Research Corp.
Second St. Pike
Southampton, Pa.

Nucleonic Corp. of America
499 Union St.
Brooklyn 31, N. Y.

O

Ogden Iron Works
185 23 St.
Ogden, Utah

Ohio Brass Co.
Mansfield, Ohio

Ohio Carbon Co.
12508 Berea Rd.
Cleveland 11, Ohio

Ohio Electric Mfg. Co.
5900 Maurice Ave.
Cleveland 27, Ohio

Ohio Forge & Machine Corp.
3010 Woodhill Rd.
Cleveland 4, Ohio

Ohio Gear Co.
1333 E. 179th St.
Cleveland 10, Ohio

Ohio Grease Co.
525 N. Spring St.
Loudonville, Ohio

Ohio Hoist & Mfg. Co., Inc.
321 South Beaver St.
Lisbon, Ohio

Ohio Injector Co.
275 Main St.
Wadsworth, Ohio

Ohio Locomotives Crane Co.
1816 Southern Ave.
Bucyrus, Ohio

Ohio Oil Co.
Findlay, Ohio

Oilgear Co.
1560 W. Pierce St.
Milwaukee 4, Wis.

Okadee Co.
332 S. Michigan Ave.
Chicago 4, Ill.

O.K. Machinery Div.
John C. Motter Printing Press Co.
Columbia, Pa.

Okonite Co.
Hazard Insulated Wire Works Div.
Passaic, N. J., p. 196

Olds Alloy Co.
4481 Mason St., South Gate, Calif.

Olin-Mathieson Chemical Corp.
Explosives Div.
East Alton, Ill.

Oliver Corp.
400 West Madison
Chicago 6, Ill.

Oliver Corp.
A. B. Farquhar Div.
142 N. Duke St.
York, Pa.

Oliver Iron & Steel Corp.
S. 10th & Muriel Sts.
Pittsburgh 3, Pa.

Omega Machine Co.
345 Harris Ave.
Providence 1, R. I.

Onan & Sons, Inc., D. W.
University Ave. S.E. at 25th
Minneapolis 14, Minn.

Onox, Inc.
121 Second St.
San Francisco 5, Calif.

Orange Roller Bearing Co., Inc.
557 Main St.
Orange, N. J.

Ore & Chemical Corp.
80 Broad St.
New York, N. Y.

Oronite Chemical Co.
38 Sansome St.
San Francisco Calif.

Orton Crane & Shovel Co.
608 S. Dearborn St.
Chicago 5, Ill.

Oshkosh Motor Truck, Inc.
2300 Oregon St.
Oshkosh, Wis.

Osmose Wood Preserving Co.
980 Ellicott St.
Buffalo 9, N. Y.

Ottumwa Box Car Loader Co.
Ottumwa, Iowa

Overseas Raw Materials Corp.
11 Broadway
New York, N. Y.

Overstrom & Sons, Inc.
2213 West Mission Rd.
Alhambra, Calif.

Owatonna Tool Co.
353 Cedar St.
Owatonna, Minn.

Owen Bucket Co.
6001 Breakwater Ave.
Cleveland 2, Ohio

Owens-Corning Fibreglas Corp.
16 East 56th St.
New York, N. Y.

O. Z. Electrical Mfg. Co.
262 Bond St.
Brooklyn 2, N. Y.

P

Pacific Coast Engineering Co.
Oak & Cement Sts.
Alameda 6, Calif.

Pacific Foundry Co., Ltd.
3100 19th St.
San Francisco 10, Calif.

Pacific Lumber Co.
100 Bush St.
San Francisco, Calif.

Pacific Wire Rope Co.
1840 E. 15th St.
Los Angeles, Calif.

Pacific Wood Tank Corp.
461 Market St.
San Francisco 5, Calif.

Packsack Diamond Drills Limited
1385 Hammond St.
North Bay Ontario
Canada

Page Engineering Co.
Clearing Post Office
Chicago 38, Ill.

Palnut Co.
Glen Rd.
Mountainside, N. J.

Pangborn Corp.
630 Pangborn Blvd.
Hagerstown, Md.

Paragon Electric Co.
1600 12 St.
Two Rivers, Wis.

Paragon-Revolute Corp.
97 South Ave.
Rochester 4, N. Y.

Parker Electrical Mfg. Co.
221 Washington St.
Oakland 7, Calif.

Parker Safety Equipment Co.
785 Lyons Ave.
Irvington 11, N. J.

Parsons Engineering Corp.
4590 Beidler Rd.
Willoughby, Ohio

Partrick & Wilkins Co.
51 N. 7th St.
Philadelphia 6, Pa.

Patrick, Inc., R. S.
Sellwood Bldg.
Duluth 2, Minn.

Patten Engineering Co.
1745 Blake St.
Denver 2, Colo.

Patterson Foundry & Machine Co.
41 Helene St.
East Liverpool, Ohio

Patton Mfg. Co., Inc.
West Pleasant & Thomas Sts.
Springfield, Ohio

Paulsen-Webber Cordage Corp.
170 John St.
New York, N. Y.

Pease Co., C. F.
2601 W. Irving Park Rd.
Chicago, Ill.

Peck & Harvey Mfg. Corp.
5650 North Western Ave.
Chicago 45, Ill.

Peerless Electric Co.
1401 W. Market St.
Warren, Ohio

Peerless Machine Co.
1600 Junction Ave.
Racine, Wis.

Peerless Photo Products, Inc.
Shoreham, N. Y.

Penberthy Injector Co.
1242 Holden Ave.
Detroit 2, Mich.

Pendleton Woolen Mills
Washougal, Wash.

Penn Machine Co.
106 Station St.
Johnstown, Pa.

Penn Mfg. & Supply Co.
45 Westminster St.
Wilkes-Barre, Pa.

Pennsylvania Crusher Div.
Bath Iron Works Corp.
Rm. 1712
West Chester, Pa.

Pennsylvania Drilling Co.
1201 Chartiers Ave.
Pittsburgh 20, Pa.

Pennsylvania Pump & Compressor Co.
Easton, Pa.

Pennsylvania Transformer Co.
Box 330, Canonsburg, Pa.

Perkin Engineering Co.
345 Kansas St.
El Segundo, Calif.

Perkins Machine & Gear Co.
West Springfield, Mass.

Permagile Corp. of America
37-23 33rd St.
Long Island City 1, N. Y.

Permold Co.
800 W. Liberty St.
Medina, Ohio

Permutit Co.
330 W. 42nd St.
New York 36, N. Y.

Peterson Filters & Engr. Co.
137 Social Hall Ave.
Salt Lake City 1, Utah

Pettibone Mulliken Corp.
4710 W. Division St.
Chicago 51, Ill.

Pettinos, Inc., George F.
1206 Locust St.
Philadelphia 7, Pa.

Phelps Dodge Copper Products Corp.
300 Park Ave.
New York 22, N. Y.

Philadelphia Belting Co.
6th & Spring Garden Sts.
Philadelphia 23, Pa.

Philadelhpia Gear Works
G St. & Erie Ave.
Philadelphia 34, Pa.

Philadelphia Quartz Co.
1146 Public Ledger Bldg.
Philadelphia 6, Pa.

Philadelphia Steel & Iron Co.
Conshohocken, Pa.

Philipp Bros., Inc.
70 Pine St.
New York 5, N. Y.

Phillips Corp.
Arch St., Carnegie, Pa...

Phillips Petroleum Co.
Bartlesville, Okla.

Phoenix Iron & Steel Co.
Phoenixville, Pa.

Phoenix Metal Products Co.
4715 N. 27th St.
Milwaukee, Wis.

Phosphor Bronze Corp.
20 Franklin St.
Seymour, Conn.

Photonraphic Survey Corp., Ltd.
Toronto
Canada

Pioneer Engineering Works, Inc.
1515 Central Ave.
Minneapolis 13, Minn.

Pioneer Rubber Mills
345 Sacramento St.
San Francisco 11, Calif.

Pitkin, Inc., Lucius
47 Fulton St.
New York 38, N. Y.

Pitman Manufacturing Co.
300 West 79 Terrace
Kansas City 2, Mo.

Pittsburgh-Des Moines Steel Co.
Neville Island
Pittsburgh 25, Pa.

Pittsburgh Electrical & Machine Works
123 Barker Pl.
Pittsburgh 22, Pa.

Pittsburgh Gear Co.
27th and Smallman Sts.
Pittsburgh 22, Pa.

Pittsburgh Knife & Forge Co.
1421 Reedsdale St.
Pittsburgh 12, Pa.

Pittsburgh Lectromelt Furnace Corp.
Foot of 32nd St.
Pittsburgh, Pa.

Pittsburgh Plate Glass Co.
Columbia-Southern Div.
1 Gateway Center
Pittsburgh 22, Pa.

Pittsburgh Reflector Co.
Oliver Bldg.
Pittsburgh 22, Pa.

Pittsburgh Screw & Bolt Co.
P. O. Box 1708
Pittsburgh 30, Pa.

Plasteel Products Corp.
15 McAdam Ave.
Washington, Pa.

Plastex Pipe & Extrusion Co.
402 Mt. Vernon Ave.
Columbus 3, Ohio

Platt Iron Works
435 Keowee St.
Dayton 1, Ohio

Plummer Mfg. Co., W. A.
752 S. San Pedro St.
Los Angeles 14, Calif.

Plymouth Locomotive Works Div.
Fate-Root-Heath Co.
Plymouth, Ohio, p. 239

Plymouth Rubber Co.
Canton, Mass.

Poole Foundry & Machine Co.
1700 Union Ave.
Baltimore 11, Md.

Porter-Cable Machine Co.
1714 N. Salina St.
Syracuse 8, N. Y.

Porter Co., Inc., H. K.
Quaker Pioneer Rubber Div.
520 Fourth St.
San Francisco 7, Calif.

Porter Co., H. K.
Quaker Rubber Co. Div.
Tasony & Comly Sts.
Philadelphia 24, Pa.

Portland Woolen Mills, Inc.
Industrial Fabrics Div.
6639 N. Baltimore Ave.
P. O. Box 2620
Portland 3, Ore.

Porto Pump Inc.
19735 Ralston
Detroit 3, Mich.

Posey Iron Works, Inc.
560 Prince St.
Lancaster, Pa.

Post Co., Frederick
3650 N. Avondale Ave.
Chicago 18, Ill.

Post-Glover Electric Co.
221 W. 3rd St.
Cincinnati 2, Ohio

Powell Co., Wm.
2525 Spring Grove Ave.
Cincinnati 22, Ohio

Powercraft Corp.
2215 De Kalb St.
St. Louis 4, Mo.

Prat-Daniel Corp.
Thermobloc Div.
2 Meadow St.
South Norwalk, Conn.

Precision Chain Co.
Terre Haute, Ind.

Precision Grinding Wheel Co., Inc.
8301 Torresdale Ave.
Philadelphia 36, Pa.

Precision Radiation Instruments, Inc.
4223 West Jefferson Blvd.
Los Angeles 16, Calif.

Precision Thermometer & Instrument Co.
1434 Brandywine St.
Philadelphia 30, Pa.

Prescott Co.—Sterling Engine Co.
Menominee, Mich.

Pressed Steel Car Div.
U. S. Industries, Inc.
250 Park Ave.
New York 17, N. Y.

Prime Mover Co.
Muscatine, Iowa

Princeton Gripholst, Inc.
32 George St.
Boston 19, Mass., page 284

Prins & Associates K.
Wellston, Ohio

Process Engineers, Inc.
Foot of Chase St.
Methuen, Mass.

Productive Equipment Corp.
2926 W. Lake St.
Chicago 12, Ill.

Frank Prox Co., Inc.
Terre Haute, Ind.

Pulmosan Safety Equipment Corp.
644 Pacific St.
Brooklyn, N. Y.

Pulva Corp.
602 High St., Perth Amboy, N. J.

Punch-Lok Co.
321 North Justine St.
Chicago 7, Ill.

Pure Carbon Co.
441 Hall Ave., St. Marys, Pa.

Pure Oil Co.
35 E. Wacker Drive
Chicago 1, Ill.

Purolator Products, Inc.
970 New Brunswick Ave.
Rahway, N. J.

Pyle-National Co.
1328 N. Kostner Ave.
Chicago 51, Ill.

Q

Queen City Machine Tool Co.
3900 Kellogg Ave.
Cincinnati 26, Ohio

Quick Change, Inc.
1750 N. E. 10th St.
Oklahoma City, Okla.

Quick-Seal Products, Inc.
Herndon, Pa.

Quick-Way Truck Shovel Co.
4150 Josephine St.
Denver, Colo.

Quigley Co., Inc.
527 Fifth Ave.
New York 17, N. Y.

R

Racine Steel Castings Co.
1442 Forest St., Racine, Wis.

Radiac Co., Inc.
489 Fifth Ave.
New York 17, N. Y.

Radiation Counter Laboratories
5121 W. Grove St.
Skokie, Ill.

Radio Corp. of America
Communications Products Dept.
Camden 2, N. J.

Raniville Co., F.
241 Pearl St. N. W.
Grand Rapids 2, Mich.

Rankin Manufacturing Co.
616 Marengo Ave.
Alhambra 2, Calif.

Rattan Mfg. Co.
550 State St., New Haven 7, Conn.
New Haven 7, Conn.

Rawson Electrical Instrument Co.
102 Potter St.
Cambridge 42, Mass.

Raybestos-Manhattan, Inc.
Manhattan Rubber Div.
42 Townsend St.
Passaic, N. J., p. 163

Raymond Bag Corp.
Middleton, Ohio

Ray-O-Vac Co.
212 E. Washington Ave.
Madison 10, Wis.

Read Standard Corp.
York, Pa.

Reading Crane & Hoist Corp.
Box 1139
Reading, Pa.

Ready Power Co.
11231 Freud Ave.
Detroit, Mich.

Realty & Industrial Corp.
Roller-Smith Div.
1768 W. Market St.
Bethlehem, Pa.

Recoveries, Inc.
Box D, U. S. Post Office
Sacramento 1, Calif.

Red Jacket Company, Inc.
500 Bell Avenue
Carnegie, Pennsylvania, p. 284

Reed Roller Bit Co.
Box 2119
Houston 1, Tex.

Reeves Pulley Co.
1225 - 7th St.
Columbus, Ind.

Reich Bros. Mfg. Co.
1439 Ash St.
Terre Haute, Ind., Fourth cover

Reilly Tar & Chemical Corp.
Merchants Bank Bldg.
Indianapolis 4, Ind.

Reinties Co., George P.
2519 Jefferson St.
Kansas City 6, Mo.

Reliance Electric & Engineering Co.
1088 Ivanhoe Rd.
Cleveland 10, Ohio

Reliance Steel Casting Co.
2818 Smallman Ave.
Pittsburgh 22, Pa.

Rem Cru Titanium, Inc.
Midland, Pa.

Remington Rand Div.
Sperry Rand Corp.
315 Fourth Ave.
New York 10, N. Y.

Remaly Mfg. Co.
Cedar St.
Tamaqua, Pa.

Reo Motors, Inc.
1331 S. Washington St.
Lansing 20, Mich.

Republic Creosoting Co.
Merchants Bank Bldg.
Indianapolis 6, Ind.

Republic Flow Meters Co.
2240 Diversey Pkwy.
Chicago 47, Ill.

Republic Rubber Div.
Lee Rubber & Tire Corp.
Albert St.
Youngstown, Ohio

Republic Steel Corp.
Republic Bldg.
Cleveland 1, Ohio

Republic Steel Corp.
Truscon Steel Div.
Albert St.
Youngstown 1, Ohio

Research-Cottrell, Inc.
Bound Brook, N. J.

Resisto-Loy Co., Inc.
1251 Phillips Ave., S. W.
Grand Rapids 7, Mich.

Resources Development Corp.
1540 Court Place
Denver, Colo.

Revere Corp. of America
Wallingford, Conn., p. 242

Revere Copper & Brass, Inc.
230 Park Ave.
New York 17, N. Y.

Reynolds Metals Co.
2500 S. 3rd St.
Louisville 1, Ky.

Reynolds Overseas
68 Ware Street
New York, N. Y.

Rhoads & Son, J. E.
2100 W. Eleventh St.
Wilmington 99, Del.

Riblet Tramway Co.
1231 N. Washington St.
Spokane, Wash., p. 224

Rice Pump & Machine Co.
Belgium, Wis.

Richards-Wilcox Mfg. Co.
1176 - 3rd St., Aurora, Ill.

Richardson Scale Co.
Clifton, N. J.

Ridge Equipment Co.
Fallentimber, Pa.

Riegel Textile Corp.
260 Madison Ave.
New York, N. Y.

Ritter Products Corp.
Ritter Park, Rochester 3, N. Y.

Robbins & Myers, Inc.
1345 Lagonda Ave.
Springfield, Ohio

Robertson Co., H. H.
Farmers Bank Bldg.
Pittsburgh 22, Pa.

Robinson Air-Activated Conveyor Systems
80 Fifth Ave.
New York 11, N. Y.

Rochester Ropes, Inc.
Culpepper, Va.

Rockbestos Products Corp.
Nicoll & Canner Sts.
New Haven 4, Conn.

Rockford Bolt & Steel Co.
126 Mill St., Rockford, Ill.

Rockwell Mfg. Co.
400 N. Lexington Ave.
Pittsburgh 8, Pa.

Rockwell Spring & Axle Co.
Timken-Detroit Axle Div.
100 Clark St., Detroit, Mich.

Rocky Mountain Instrument Co.
1410 - 16th St.
Denver, Colo.

Rodriguez & Gillespie Co.
P. O. Box 802
Belmont, Calif.

Rogers Brothers Corp.
Albion, Pa.

Rogers Iron Works Co.
Joplin, Mo.

Rohm & Haas Co.
712 Locust St.
Philadelphia, Pa.

Roller Bearing Co. of America
Sullivan Way
West Trenton, N. J.

Rollway Bearing Co., Inc.
541 Seymour St.
Syracuse 4, N. Y.

Rome Cable Corp.
330 Ridge St., Rome, N. Y.

Root & Simpson, Inc.
1306 E. 17th Ave.
Denver 1, Colo.

Rose Mfg. Co.
2700 W. Barberry Place
Denver 4, Colo.

Ross Heat Exchanger Div.
American Standard
1407 West Ave.
Buffalo 13, N. Y.

Ross Screen & Feeder Co.
100 Quimby St.
Westfield, N. J., p. 223

Round & Son, Inc., David
P. O. Box 883
Cleveland 22, Ohio

Royal Electric Mfg. Co.
1122 E. 87 St.
Chicago 19, Ill.

Royston Laboratories
Blawnox, Pittsburgh 38, Pa.

Ruberoid Co.
500 Fifth Ave.
New York 36, N. Y.

Rust Furnace Co.
575 Sixth Ave.
Pittsburgh 19, Pa.

Rust-Oleum Corp.
2425 Oakton St.
Evanston, Ill.

Ruth Co.
1437 Blake St.
Denver 2, Colo.

Ryerson & Son, Inc., Joseph T.
16 & Rockwell Sts.
P. O. Box 8000 A
Chicago 80, Ill.

S

Safety Clothing & Equipment Co.
7016 Euclid Ave.
Cleveland 3, Ohio

Safety First Shoe Co.
Holliston, Mass.

Safety First Supply Co.
425 Magee St.
Pittsburgh 19, Pa.

Saginaw Bearing Co.
821 South Water St.
Saginaw, Mich.

St. Louis Malleable Casting Co.
7701 N. Conduit Ave.
St. Louis 15, Mo.

St. Louis Screw & Bolt Co.
6900 North Broadway
St. Louis 15, Mo.

St. Regis Paper Co.
230 Park Ave.
New York 17, N. Y.

Salem-Brosius, Inc.
P. O. Box 2222
Pittsburgh 30, Pa.

Salem Tool Co.
Salem, Ohio, p. 11

Samuel & Co., Inc., Frank
2200 Philadelphia National Bank Bldg.
Philadelphia 7, Pa.

Sanderson Cyclone Drill Co.
E. Chestnut St.
Orrville, Ohio

Sanford-Day Iron Works, Inc.
Dale Ave.
P. O. Box 1511
Knoxville 9, Tenn.

Sanford-Day Iron Works
Brown-Fayro Div.
1937 Brown St.
Johnstown, Pa.

Sangamo Electric Co.
Springfield, Ill.

Santa Fe Tank & Tower Co.
5401 S. Boyle Ave.
Los Angeles 11, Calif.

Sarco Co., Inc.
350 Fifth Ave.
New York 1, N. Y.

Sauereisen Cement Co.
1242 Sharpsburg St.
Pittsburgh 15, Pa.

Sauerman Bros., Inc.
626 S. 28th Ave.
Bellwood, Ill.

Savage Co., W. J.
912 W. Clinch Ave.
Knoxville 16, Tenn.

Sawyer Belt Hook & Wedge Co., Inc.
16 Warren Ave.
Pawtucket, R. I.

Saylor Electric Products Corp.
277 Pierce
Birmingham, Mich.

Scandinavia Belting Co.
744 Broad St., Box 464
Newark 1, N. J.

Schaffer Poidometer Co.
2828 Smallman St.
Pittsburgh 22, Pa., p. 234

Schatz Mfg. Co.
Fairview Ave.
Poughkeepsie, N. Y.

Schield Bantam Co.
221 Park St.
Waverly, Iowa

Schieren Co., Charles A.
Box 533
Camden 1, N. J.

Schneible Co., Claude B.
P. O. Box 81
North End Station
Detroit 2, Mich.

Schonrock Equipment Mfg. Co.
San Angelo, Tex.

Schrader Co., F. W.
11623 S. Broadway
Los Angeles 61, Calif.

Schramm, Inc.
West Chester, Pa., p. 213

Schroeder Brothers
3116 Penn Ave.
Pittsburgh 1, Pa.

Schutte & Koerting Co.
Cornwells Heights
Bucks Co., Pa.

Scott Aviation Corp.
Lancaster, N. Y.

Screen Equipment Co., Inc.
1750 Walden Ave.
Buffalo 25, N. Y.

Security Locknut Corp.
1800 15th Ave.
Melrose Park, Ill.

Seiberling Rubber Co.
Akron 9, Ohio

Seismograph Service Corp.
P. O. Box 1590
Tulsa 1, Okla.

Sellstrom Mfg. Co.
217 So. Hicks Rd.
Palatine, Ill.

Seymour Mfg. Co.
39 Franklin St.
Seymour, Conn.

Shaffer Tool Works
209 South Pomona
La Brea, Calif.

Shaft & Development Machines Co.
808 Newhouse Bldg.
Salt Lake City 1, Utah, p. 232

Sharp Instruments, Ltd.
Toronto
Canada

Sharples Chemicals Div.
Pennsylvania Salt Mfg. Co.
3 Penn Center Plaza
Philadelphia 2, Pa.

Shawinigan Products Corp.
Empire State Bldg.
350 Fifth Ave.
New York 11, N. Y.

Sheffield Steel Div.
Armco Steel Corp.
Sheffield Station
Kansas City 25, Mo.

Shell Oil Co.
50 W. 50th St.
New York 20, N. Y.

Shepard Niles Crane & Hoist Corp.
Schuyler Ave.
Montour Falls, N. Y.

Sheppard Co., Inc., R. H.
Hanover, Pa.

Sherwin Instrument Co.
2875 Broadway
New York 25, N. Y.

Sherwin-Williams Co.
101 Prospect Ave. N. W.
Cleveland 1, Ohio

Shriver & Co., T.
848 Hamilton St.
Harrison, N. J.

Shwayder Chemical Metallurgy Corp.
684 E. Woodbridge
Detroit 26, Mich.

Sight Feed Generator Co.
West Alexandria, Ohio

Sika Chemical Corp.
33-47 Gregory Ave.
Passaic, N. J.

Sikes Co., S. R.
1028 S. 3rd St.
Minneapolis 15, Minn.

Sikorsky Division
United Aircraft Co.
East Hartford, Conn.

Silent Hoist & Crane Corp.
877—63rd St.
Brooklyn 20, N. Y.

Simonds Saw & Steel Co.
Fitchburg, Mass.

Simonds Worden White Co.
Dayton 7, Ohio

Simplex Wire & Cable Co.
79 Sidney St.
Cambridge 39, Mass.

Simplicity Engineering Co.
Durand, Mich., p. 8

Simplicity System Co.
Riverside Drive
East Chattanooga, Tenn.

Sinclair Refining Co.
600 Fifth Ave.
New York, N. Y.

SKF Industries, Inc.
P. O. Box 6731
Philadelphia 32, Pa.

Skinner Engine Co.
337 W. 12th St.
Erie, Pa.

Skookum Co.
8504 N. Crawford St.
Portland 3, Ore.

Slip-On, Inc.
401 Broadway
New York, N. Y.

Sly Mfg. Co., W. W.
P. O. Box 5939
Cleveland 1, Ohio

Smidth & Co., F. L.
11 West 42nd St.
New York 36, N. Y., page 173

Smit & Co., Anton
111 Eighth Ave.
New York 11, N. Y., page 248

Smit & Sons, Inc., J. K.
Murray Hill, N. J., page 208

Smith Co., A. O.
3533 North 27th St.
Milwaukee 1, Wis.

Smith-Emery Co.
920 Santee St.
Los Angeles 15, Calif.

Smith Engineering Works
502 East Capital Dr.
Milwaukee 12, Wis.

Smith & Co., Gordon
445 College St.
Bowling Green, Ky.

Smith & Serrell, Inc.
200 Washington St.
Newark 2, N. J.

Smith Welding Equipment Corp.
2633 S. E. 4th St.
Minneapolis 14, Minn.

Smoot-Holman Co.
321 N. Eucalyptus Ave.
Inglewood, Calif.

Snap-on-Tools Corp.
8026 28 Ave.
Kenosha, Wis.

Snap-Tite, Inc.
201 Titusville Rd.
Union City, Pa.

Snell, Inc., Foster D.
29 W. 15th St.
New York 11, N. Y.

Snow-Babstedt Gear Corp.
251 Welton St.
Hamden 7, Conn.

Snyder & Son, Inc., M. L.
1811 E. York St.
Philadelphia 25, Pa.

Societe Aerienne de Recherches Minieres
52 Ave. de Neuilly
Neuilly-sur-Seine, France

Socony Mobil Oil Co.
26 Broadway
New York 4, N. Y.

Solvay Process Div.
Allied Chemical & Dye Corp.
61 Broadway
New York 6, N. Y.

Sonneborn Sons, Inc., L.
300 4th Ave.
New York 10, N. Y.

Sorel Steel Foundries, Ltd.
1405 Peel St.
Montreal, Canada

Sorgel Electric Co.
838-8 W. National Ave.
Milwaukee 4, Wis.

Soule Steel Co.
1750 Army St.
San Francisco 24, Calif.

South Bend Air Products, Inc.
322 E. Colfax Ave.
South Bend 22, Ind.

South Bend Lathe Works
419 E. Madison St.
South Bend 22, Ind.

Southeastern Diamond Drilling Co.
Jackson Bldg. Annex
Asheville, N. C.

Southern Carbon Brush Co.
7 18th St., S. W.
Birmingham, Ala.

Southern Friction Materials Co.
Charlotte 1, N. C.

Southern Oxygen Co.
P. O. Box 5087
Washington 19, D. C.

Southwestern Engineering Co.
4800 Santa Fe Ave.
Los Angeles 58, Calif.

Southwestern Industrial Electronics Co.
P. O. Box 13058
Houston 19, Tex.

Southwestern Petroleum Co.
Fort Worth, Tex.

Spang & Co.
143 Etna St.
Butler, Pa.

Spartan Air Services, Ltd.
Ottawa, Canada

Special Instruments Laboratory, Inc.
P. O. Box 2108
312 W. Vine Ave.
Knoxville, Tenn.

Specialty Engineering Co.
8701 Torresdale Ave.
Philadelphia 36, Pa.

Speer Carbon Co.
St. Marys, Pa.

Spencer Turbine Co.
486 New Park Ave.
Hartford 6, Conn.

Sperry Corp.
Wheeler Insulated Wire Co.
Waterbury, Conn.

Split Ballbearing Corp.
21 Mascoma St.
Lebanon, N. H.

Sprague & Henwood, Inc.
221 West Olive St.
Scranton, Pa., opp. p. 162

Spray Engineering Co.
114 Central St.
Somerville 45, Mass.

Sprengnether Instrument Co., Inc., W. F.
4567 Swan Ave.
St. Louis 10, Mo.

Springfield Boiler Co.
20th & E. Capitol Ave.
Springfield, Ill.

Square D Co.
6060 Rivard St.
Detroit 11, Mich.

Stackpole Carbon Co.
St. Marys, Pa.

Stahl Gear & Machine Co.
3901 Hamilton Ave.
Cleveland 14, Ohio

Stamler Corp., W. R.
Box 79
Paris, Ky., page 244

Standard Elec. Mfg. Co., Inc.
Haddon Ave.
West Berlin, N. J.

Standard Electrical Tool Co.
2488 River Rd.
Cincinnati 4, Ohio

Standard Metal Mfg. Co.
Malinta, Ohio

Standard Oil Co. of California
Western Div.
225 Bush St.
San Francisco 20, Calif., page 175

Standard Oil Co.—Indiana
910 S. Michigan Ave.
Chicago 80, Ill.

Standard Steel Corp.
5001 S. Boyle Ave.
Los Angeles 58, Calif.

Standard Transformer Co.
Warren, Ohio

Stanley Co., Inc., William W.
401 Broadway
New York 13, N. Y.

Stanley Electric Tools Div.
Stanley Works, New Britain, Conn.

Staplex Co.
Air Sampler Div.
777 Fifth Ave.
Brooklyn 32, N. Y.

Star Brass Works
1501 Fulford St.
Kalamazoo 24F, Mich.

Star Expansion
142 Liberty St.
New York 6, N. Y.

Star Jack Co.
420 Lexington Ave.
New York 17, N. Y.

Stardrill-Keystone Co.
920 17th St.
Beaver Falls, Pa.

Star Wire Screen & Iron Works
2515 San Fernando Road
Los Angeles 65, Calif.

Stearns Magnetic, Inc.
659 S. 28th St.
Milwaukee 46, Wis., page 10

Stearns Roger Mfg. Co.
660 Bannock St.
Denver 4, Colo., page 219

Steber Mfg. Co.
2700 Roosevelt Rd.
Broadview, Ill.

Steel-Bilt Construction Co.
Carol Ave., Bridgeville, Pa.

Steelcraft Mfg. Co.
9066 Blue Ash Road
Rossmoyne
Cincinnati, Ohio

Stein, Hall & Co., Inc.
285 Madison Ave.
New York, N. Y.

Stephens-Adamson Mfg. Co.
82 Ridgeway Ave.
Aurora, Ill.

Sterling Electric Motors, Inc.
Telegraph Rd. at Atlantic Blvd.
Los Angeles 22, Calif.

Sterling Grinding Wheel Co.
Tiffin, Ohio

Sterling Steel Casting Co.
P. O. Box 230
East St. Louis, Ill.

Steward & Romaine Mfg. Co.
124 N. 6th St.
Philadelphia 6, Pa.

Stewart-Warner Corp.
Alemite Div.
1826 Diversey Parkway
Chicago 14, Ill.

Stimmel Winch Co., Inc.
37-24 33 St.
Long Island City, N. Y.

Stockham Valves & Fittings
Birmingham, Ala.

Stone & Webster Engineering Co.
90 Broad St.
New York, N. Y.

Stoody Co.
P. O. Box 901
Whittier, Calif., page 205

Stop Fire, Inc.
125 Ashland Place
Brooklyn 1, N. Y.

Stowell & Co., W. H.
W. 421 Sprague Ave.
Spokane 4, Wash.

Stratoflex, Inc.
P. O. Box 10398
Fort Worth, Tex.

Straub Mfg. Co.
8381 Baldwin St.
Oakland 21, Calif.

Strauss & Co., Inc., A.
17 State St.
New York 4, N. Y.

Streeter-Amet Co.
4107 Ravenswood Ave.
Chicago, Ill.

Stroh Process Steel Co.
1428 High St.
Pittsburgh 12, Pa.

Strong, Carlisle & Hammond Co.
1392 W. 3rd St.
Cleveland 13, Ohio

Strong Steel Foundry Co.
Hertel & Norris Ave.
Buffalo 7, N. Y.

Stulz-Sickles Co.
134 Lafayette St.
Newark 5, N. J.

Sturtevant Mill Co.
103 Clayton St.
Boston 22, Mass.

Sunbury Wire Rope Mfg. Co.
880 South Second St.
Sunbury, Pa.

Sun Oil Co.
1608 Walnut St.
Philadelphia 3, Pa.

Superior Carbon Products, Inc.
9115 George Ave.
Cleveland 5, Ohio

Superior-Lidgerwood-Mundy Corp.
1101 John Ave.
Superior, Wis.

Sutphen, Peter O.
Box 58
Everett, Pa.

Sutton, Steele & Steele, Inc.
1031 S. Haskell St.
Dallas 10, Tex.

Suverkrop Instruments
P. O. Box 436
Bakersfield, Calif.

Swaby Mfg. Co.
3818 W. Armitage Ave.
Chicago 47, Ill.

Swan-Finch Oil Corp.
338 Hudson St.
Hackensack, N. J.

Sweet's Steel Co.
770 Sweet St.
Williamsport, Pa.

Swepco Tube Corp.
One Clifton Blvd.
Clifton, N. J.

Swett Iron Works, A. L.
158 Glenwood Ave.
Medina, N. Y.

Sylvania Electric Products, Inc.
1740 Broadway
New York 19, N. Y.

Snyder Mine & Chemical Lab.
Box 212
Richmond, Ore.

Synthane Corp.
River Rd.
Oaks, Pa.

Syntron Co.
510 Lexington
Homer City, Pa.

T

Talcott, Inc., W. O. & M. W.
81 Sabin St.
Providence, R. I.

Talk-A-Phone Co.
1512 South Pulaski Rd.
Chicago 23, Ill.

Taller & Cooper, Inc.
75 Front St.
Brooklyn, N. Y.

Tamping Bag Co.
218 S. 3rd St., Mt. Vernon, Ill.

Taylor & Co., W. A.
7300 York Rd.
Baltimore 4, Md.

Taylor Chain Co., S. G.
141 St. & Ind. Harbor Belt Tracks
Hammond, Ind.

Taylor Fibre Co.
Norristown, Pa.

Taylor Forge & Pipe Works
P. O. Box 485
Chicago 90, Ill.

Taylor Instrument Co.
100 Ames St.
Rochester 1, N. Y.

Taylor-Wharton Co. Div.
Harsco Corp.
High Bridge N. J.

Technical Associates
140 W. Providencia Ave.
Burbank, Calif.

Tema, N. V.
Nassaulaan 1
The Hague
Netherlands

Templeton, Kenly & Co.
16th & Gardner Rd.
Broadview, Ill.

Tennant Sons & Co., C. of N. Y.
Sink & Float Div.
100 Park Ave.
New York 17, N. Y.

Tennessee Coal & Iron Div.
U. S. Steel Corp.
P. O. Box 599
Fairfield, Ala., pages 162, 283

Tennessee Products & Chemical Corp.
512 First American National Bank Bldg.
Nashville 3, Tenn.

Terry Steam Turbine Co.
874 Windsor St.
Hartford, Conn.

Texas Co.
135 E. 42nd St.
New York 17, N. Y., page 6

Texas Gulf Sulphur Co.
75 East 45
New York, N. Y.

Texas Instruments, Inc.
6000 Lemmon Ave.
Dallas 9, Tex.

Thermoid Co.
Industrial Div.
Whitehead Rd.
Trenton 6, N. J.

Thew Shovel Co.
Lorain, Ohio

Thomas & Betts Co.
36 Butler St.
Elizabeth 1, N. J.

Thomas Flexible Coupling Co.
Warren, Pa.

Thomas Foundries, Inc.
3800 Tenth Ave. North
Birmingham 1, Ala.

Thompson Products, Ltd.
St. Catharines, Ontario
Canada, page 238

Thompson-Starrett Co., Inc.
Roberts & Schaefer Co. Div.
Randolph-Wells Bldg.
130 North Wells St.
Chicago 6, Ill.

Thor Power Tool Co.
175 N. State St.
Aurora, Ill., page 18

Throwaway Bit Corp.
4200 N. W. Yeon Ave.
Portland 10, Ore.

Thumes Mek. Vaerksted, A. S.
Oslo
Norway

Thurman Machine Co.
156 N. 5th St.
Columbus, Ohio

Thwing-Albert Instrument Co.
Penn St. & Pulaski Ave.
Philadelphia 44, Pa.

Tide Water Associated Oil Co.
17 Battery Place
New York 4, N. Y.

Timken Roller Bearing Co.
1835 Dueber Ave., S. W.
Canton 6, Ohio

Tinney Drilling Co.
113 W. Main St.
Grafton, W. Va.

Titan Chain Saws, Inc.
2700 Fourth Ave., South
Seattle 4, Wash.

Titan Metal Mfg. Co.
Bellefonte, Pa.

Titeflex, Inc.
Hendee St.
Springfield 4, Mass.

Toledo Pipe Threading Machine Co.
1445 Summit Ave.
Toledo 4, Ohio

Toledo Scale Co.
1002 Telegraph Rd.
Toledo 1, Ohio

Ton-Tex Corp.
247 Pearl St., N. W.
Grand Rapids 2, Mich.

Tool Steel Gear & Pinion Co.
211 Township Ave.
Cincinnati 16, Ohio

Torrington Co.
59 Field St.
Torrington, Conn.

Torrington Co.
Bantam Bearings Div.
3702 West Sample St.
South Bend 21, Ind.

Torsion Balance Co.
Clifton, N. J.

Tour & Co., Sam
44 Trinity Pl.
New York 6, N. Y.

Trabon Engineering Corp.
1814 E. 40th St.
Cleveland 3, Ohio

Tracerlab, Inc.
130 High St.
Boston 10, Mass.

Tractomotive Corp.
County Line Rd.
Deerfield, Ill.

Transall, Inc.
109 N. 11th St.
Birmingham 4, Ala.

Transport Trailers, Inc.
1230 12th St., S. W.
Cedar Rapids, Iowa

Transue & Williams Steel Forging Corp.
562 W. Ely St.
Alliance, Ohio

Traylor Engineering & Mfg. Co.
Allentown, Pa., page 16

Treadwell Co., M. H.
140 Cedar St.
New York 6, N. Y.

Treadwell Engineering Co.
Easton, Pa.

Triangle Conduit & Cable Co.
Triangle & Jersey Aves.
New Brunswick, N. J.

Trico Fuse Mfg. Co.
2948 N. 5th St.
Milwaukee 12, Wis.

Trojan Powder Co.
17 N. 7th St.
Allentown, Pa.

Trombetta Solenoid Corp.
329 N. Milwaukee St.
Milwaukee 2, Wis.

Trotter & Co., E. T.
594 Johnson Ave.
Brooklyn, N. Y.

Troy Engine & Machine Co.
3 Railroad Ave.
Troy, Pa.

Truck Engineering Corp.
1285 W. 70th St.
Cleveland 2, Ohio

Truflo Fan Co.
Harmony, Pa.

Truscon Steel Co. Div.
Republic Steel Corp.
Albert St.
Youngstown 1, Ohio

Tube Turns Div.
National Cylinder Gas Co.
224 East Broadway
Louisville 1, Ky.

Turner & Hawes Engineering Co.
87 Gardner St.
West Roxbury 32, Mass.

Turner Construction Co.
420 Lexington Ave.
New York, N. Y.

Turner Halsey Co.
40 Worth St.
New York 13, N. Y.

Tweco Products Inc.
Boston at Mosley
Wichita 1, Kan.

Twin Disc Clutch Co.
Racine, Wis., page 200

Twining Laboratories
2527 Fresno St.
Fresno, Calif.

Tyler Co., W. S.
3615 Superior Ave.
Cleveland 14, Ohio

Tyson Bearing Corp.
Subsidiary of SKF Industries, Inc.
Massillon, Ohio

U

Uehling Instrument Co.
473 Getty Ave.
Paterson 3, N. J.

Ultra-Violet Products, Inc.
5114 Walnut Grove Ave.
San Gabriel, Calif.

Union Bag & Paper Corp.
233 Broadway, New York, N. Y.

Union Carbide & Carbon Corp.
Electro Metallurgical Sls.
30 East 42nd St.
New York 17, N. Y.

Union Carbide & Carbon Corp.
Haynes Stellite Co. Div.
30 East 42nd St.
New York 17, N. Y.

Union Carbide & Carbon Corp.
Linde Air Products Co. Div.
30 East 42nd St.
New York 17, N. Y.

Union Carbide & Carbon Corp.
National Carbon Co. Div.
30 East 42nd St.
New York 17, N. Y.

Union Chain & Mfg. Co.
Sandusky, Ohio

Union Oil Co. of California
617 W. 7th St.
Los Angeles 17, Calif.

Union Iron Works
E. 217 Montgomery
Spokane, Wash.

Union Spring & Mfg. Co.
8th St. & 2nd Ave.
New Kensington, Pa.

Union Wire Rope Corp.
2100 Manchester Ave.
Kansas City 26, Mo.

Unit Crane & Shovel Corp.
6411 W. Burnham St.
Milwaukee 14, Wis.

United American Metals Corp.
193 Diamond St.
Brooklyn 22, N. Y.

U. S. Electrical Motors, Inc.
200 E. Slauson Ave.
Los Angeles 54, Calif.

U. S. Electrical Tool Co.
1050 Findlay St.
Cincinnati 14, Ohio

United States Filter Co.
1910 N. Potrero Ave.
El Monte, Calif.

United States Graphite Co. Div.
The Wickes Corp.
1621 Holland Ave., Saginaw, Mich.

U. S. Hoffman Corp.
Air Appliance Div.
105 4th Ave.
New York 3, N. Y.

U. S. Motors Corp.
Oshkosh, Wis.

U. S. Smelting, Refining & Mining Co., Inc.
57 Williams Street
New York, N. Y.

U. S. Pipe & Foundry Co.
Burlington, N. J.

United States Rubber Co.
Hose Div.
1 Market St., Passaic, N. J.

U. S. Rubber Co.
Mechanical Goods Div.
1230 Ave. of the Americas
New York 20, N. Y.

U. S. Rubber Co.
Naugatuck Chemical Div.
1230 Ave. of the Americas
New York 20, N. Y.

United States Rubber Co.
New York Belting & Packing Co. Div.
1 Market St., Passaic, N. J.

U. S. Rubber Co.
U. S. Royal Tire Division
1230 Ave. of the Americas
New York 20, N. Y.

U. S. Safety Service Co.
1331 Oak St. Dept. E.
Kansas City 6, Mo.

U. S. Smelting Furnace Co.
East A St. & L & N Tracks
Belleville, Ill.

United States Steel Corp.
525 William Penn Place
Pittsburgh 30, Pa.

United States Steel Export Co.
30 Church St.
New York 1, N. Y., pages 162, 283

U. S. Steel Corp.
American Bridge Div.
525 Wm. Penn Place
Pittsburgh 30, Pa.

U.S. Steel Corp.
American Steel & Wire Div.
Rockefeller Bldg.
Cleveland 13, Ohio

U. S. Steel Corp.
Columbia-Geneva Steel Div.
120 Montgomery St.
San Francisco 6, Calif., pages 162, 283

U. S. Steel Corp.
National Tube Div.
525 Wm. Penn Place
Pittsburgh 30, Pa., pages 162, 283

United States Steel Supply Co.
208 South LaSalle St.
Chicago 4, Ill. pages 162, 283

U. S. Testing Co.
1415 Park Ave.
Hoboken, N. J.

Universal Atomics Corp.
19 E. 48th St.
New York 17, N. Y.

Universal Dredge Mfg. Co.
124 Wazee Market
Denver 4, Colo.

Universal Engineering Corp.
625 C Ave., N. W.
Cedar Rapids, Iowa

Universal Motor Co.
422 Universal Dr.
Oshkosh, Wis.

Universal Road Machinery Co.
Kingston, N. Y.

Universal Vibrating Screen Co.
Deane Blvd. & St. Paul RR
Racine, Wis.

Universal Welder Corp.
2557 E. 79th St.
Cleveland 4, Ohio

Upson-Walton Co.
12500 Elmwood Ave.
Cleveland 11, Ohio

Utah Construction Co.
Shell Bldg.
San Francisco, Calif.

Utah Oil Refining Co.
Salt Lake City, Utah

Utilities Service Co.
1 Pine St.
Allentown, Pa.

Utility Mine Equipment Co.
1010 Collingwood Rd.
St. Louis 24, Mo.

V

Vale Do Rio Doce Trading Co., Inc.
63 Wall St.
New York 5, N. Y.

Valvoline Oil Co. Div.
Ashland Oil & Refining Co.
639 Third Ave.
Freedom, Pa.

Vanadium-Alloys Steel Co.
Latrobe, Pa.

Vanadium Corp. of America
420 Lexington Ave.
New York 17, N. Y.

Vanderbilt Co., R. T.
230 Park Ave.
New York 17, N. Y.

Van Waters & Rogers, Inc.
4000 1st St.
Seattle 4, Wash.

Varel Mfg. Co.
Box 13146, Dallas, Texas

Vascoloy-Ramet Corp.
800 Market St., Waukegan, Ill.

Vickers, Inc.
1400 Oakman Blvd.
Detroit 32, Mich.

Victaulic Co. of America
Box 509
Elizabeth, N. J., pages 170, 178

Victor Equipment Co.
Alloy Rod & Metal Div.
844 Folsom St.
San Francisco 7, Calif., page 217

Victoreen Instrument Co.
3800 Perkins Ave.
Cleveland 14, Ohio

Visking Corp.
Plastics Div.
P. O. Box 1410
Terre Haute, Ind.

Vitrified Wheel Co.
Westfield, Mass.

Vitro Corp. of America
261 Madison Ave.
New York, N. Y.

Vogt Machine Co., Henry
10th & Ormsby Sts.
Louisville 10, Ky.

Voland & Sons, Inc.
P. O. Box 680
New Rochelle, N. Y.

Vulcan Electric Co.
88 Holten St.
Danvers, Mass.

Vulcan Iron Works Co. (Denver)
1423 Stout St.
Denver 2, Colo., page 243

Vulcan Iron Works
730 S. Main St.
Wilkes-Barre, Pa.

V. V. Fittings Co.
715 Cherry St.
Philadelphia, Pa.

W

Wadsworth Electric Mfg. Co.
20 W. 11th St.
Covington, Ky.

Wagner Electric Corp.
6401 Plymouth Ave.
St. Louis, Mo.

Wah Chang Corp.
233 Broadway
New York 7, N. Y., page 174

Waldron Corp., John
River Rd.
New Brunswick, N. J.

Waljohn Plastics Co.
Industrial Div.
435-441 88 St.
Brooklyn 1, N. Y.

Walker Brothers
Spring Mill Rd.
Conshohocken, Pa.

Walker & Whyte, Inc.
409 Pearl St.
New York 7, N. Y.

Wall Colmonoy Corp.
19345 John R St.
Detroit 3, Mich.

Walsh Refractories Corp.
101 Ferry St.
St. Louis 7, Mo.

Walter Motor Truck Co.
1001 Irving Ave.
Ridgewood 27, Queens,
Long Island, N. Y.

Waltham Grinding Wheel Co.
Waltham 54, Mass.

Walvoord, Inc., O. W.
300 Detroit St.
Denver 6, Colo.

Walworth Co.
60 E. 42nd St.
New York 17, N. Y.

Ward Leonard Electric Co.
115 MacQuesten Parkway South
Mount Vernon, N. Y.

Warn Mfg. Co.
Box 6064, Riverton Branch
Seattle 88, Wash., page 234

Warren Foundry & Pipe Corp.
55 Liberty St.
New York, N. Y.

Warren-Knight Co.
136 N. 12th St.
Philadelphia 7, Pa.

Warren Steam Pump Co.
Warren, Mass.

Washington Iron Works
1520 6th Ave., S.
Seattle 4, Wash.

Washington Machinery Co.
7329 E. Marginal Way
Seattle 8, Wash.

Warner Electric Brake & Clutch Co.
Beloit, Wis.

Water Neutralizing Co.
Box 315
Columbia, Mo.

Watt Car & Wheel Co.
Barnesville, Ohio

Waukesha Motor Co.
Waukesha, Wis.

Weatherhead Co.
Fort Wayne Div.
128 W. Washington St.
Fort Wayne, Ind.

Weatherly Foundry & Mfg. Co.
Weatherly, Pa.

Webb Belting & Supply Co.
1501-07 W. 12th St.
Kansas City 1, Mo.

Webb Co., Jervis B.
8951 Alpine Ave.
Detroit 4, Mich.

Webb Corp.
Box 549
Webb City, Mo.

Webster Mfg., Inc.
Tiffin, Ohio

Wedge Bar Screen Corp.
2006 Bayport Pl.
Far Rockaway, N. Y.

Wedge Wire Corp.
Gas St. & N. P. R. R.
Wellington, Ohio, page 233

Weinman Pump Mfg. Co.
270 Spruce St.
Columbus 8, Ohio

Weir Kilby Corp.
5038 Beech St.
Cincinnati 12, Ohio

Wellington Sears Co.
65 Worth St.
New York, N. Y.

Wellman Co., S. E.
200 Egbert Rd.
Bedford, Ohio

Wellman Engineering Co.
McDowell enterprise
7000 Central Ave.
Cleveland 4, Ohio

Welsh Mfg. Co.
9 Magnolia St.
Providence 9, R. I.

West End Chemical Co.
608 Latham Square Bldg.
Oakland, Calif.

West Virginia Armature Co.
Pine St.
Bluefield, W. Va.

West Virginia Belt & Cable Repairs, Inc.
P. O. Box 361
Mt. Hope, W. Va.

West Virginia Pulp & Paper Co.
230 Park Ave.
New York 17, N. Y.

West Virginia Steel & Mfg. Co.
17 & Second Aves.
Huntington 6, W. Va.

Western Block Co.
247 Market St.
Lockport, N. Y.

Western Cartridge Co.
586 Adams St.
East Alton, Ill.

Western Gear Corp.
2600 E. Imperial Highway
Lynwood, Calif.

Western Insulated Wire Co.
2425 E. 30th St.
Los Angeles, Calif.

Western Machinery Co.
760 Folsom St.
San Francisco 7, Calif.

Western Precipitation Corp.
1016 W. 9th St.
Los Angeles 15, Calif.

Western Radiation Laboratory
1107 W. 24th St.
Los Angeles 7, Calif.

Western Rock Bit Mfg. Co.
552 W. 7th South St.
Salt Lake City 4, Utah, page 179

Westfalia Lunen
c/o Mining Progress Inc.
Highland Mills, N. Y.

Westinghouse Air Brake Co.
3 Gateway Centre
Pittsburgh 22, Pa.

Westinghouse Air Brake Co.
Cleveland Rock Drill Plant, Le Roi Div.
12500 Berea Rd.
Cleveland 11, Ohio, page 172

Westinghouse Air Brake Co.
Ind. Products Div.
Wilmerding, Pa.

Westinghouse Air Brake Co.
LeTourneau-Westinghouse Co. Div.
P. O. Box 240
Peoria 1, Ill., pages 169, 171

Westinghouse Electric Corp.
401 Liberty Ave.
Pittsburgh 30, Pa.

Westinghouse Electric Corp.
Sturtevant Div.
Hyde Park
Boston 36, Mass.

Weston Electrical Instrument Corp.
Subsidiary of Daystrom, Inc.
614 Frelinghuysen Ave.
Newark 5, N. J.

Wheel Trueing Tool Co.
3200 W. Davison Ave.
Detroit 38, Mich.

Wheelabrator Corp.
438 S. Byrkit St.
Mishawaka, Ind.

Wheelco Instr. Div.
Barber-Colman Co.
1300 Rock St., Rockford, Ill.

Wheeler Insulated Wire Co., Div.
Sperry Rand Corp.
Waterbury, Conn.

Wheeler Mfg. Co., C. H.
Lehigh & Sedgley Aves.
Philadelphia 32, Pa.

Wheeling Steel Corp.
1134-1140 Market St.
Wheeling, W. Va.

White Co., David
31 S-W Court St.
Milwaukee 12, Wis.

White Diesel Engine Div.
White Motor Co.
1401 Sheridan Ave.
Springfield, Ohio

White Lamb Finaly, Inc.
241 Chestnut St.
Philadelphia 6, Pa.

White Motor Co.
842 East 79 St.
Cleveland 1, Ohio

Whites Electronics
1218 M Street
Sweet Home, Ore., page 216

Whiting Corp.
157th St., Harvey, Ill.

Whitmore Mfg. Co.
Iron St. & Erie R. R.
Cleveland 15, Ohio

Whitney Chain Co.
237 Hamilton St., Hartford 2, Conn.

Wickes Boiler Co. Div.
Wickes Corp.
515 N. Washington Ave.
Saginaw, Mich.

Wilbur & Williams Co.
130 Lincoln St.
Brighton, Boston 35, Mass.

Wild Heerbrugg Instruments, Inc.
Main & Covert Sts.
Port Washington, N. Y.

Wiley Mfg. Co.
Port Deposit, Md.

Willey & Sons, A. R.
Denham Bldg.
P. O. Box 2330
Denver 2, Colo., page 250

Wilkerson Corp.
1601 West Girard Ave.
Englewood, Colo.

Willamette Iron & Steel Co.
2800 N. W. Front Ave.
Portland, Ore.

Willey's Carbide Tool Co.
1340 West Vernon Highway
Detroit, Mich.

Williams & Green
Old Town Rd., Clearfield, Pa.

Williams, I. B. & Sons
51 Washington St.
Dover, N. H.

Williams Patent Crusher & Pulverizer Co.
810 Montgomery St.
St. Louis 6, Mo.

Williams & Son, E. A.
325 Washington Ave.
Carlstadt, N. J.

Willson Products Div.
Ray-O-Vac Co.
200 Thorn St., Reading, Pa.

Willys Motors, Inc.
Administration Bldg.
Toledo, Ohio

Wilmot Engineering Co.
Markle Bank Bldg.
Hazelton, Pa.

Windeler Co., Ltd., George
2201 Jerrold Ave.
San Francisco 24, Calif.

Wing Mfg. Co., L. J.
303 Vreeland Mills Rd.
Linden, N. J.

Winston Bros. Co.
1470 Northwestern Bank Bldg.
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Winter Weiss Co.
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Calumet & Hecla, Inc.
Guardian Towers, Guardian Bldg.
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Wood Steel Co., Alan
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Stambaugh Bldg.
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Yuba Manufacturing Co.
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San Francisco 4, Calif., page 224

Z

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Munich, Germany

Zophar Mills
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Zurn Mfg. Co., J. A.
1955 Pittsburgh Ave., Erie, Pa.

The classified advertising in **E&MJ's SEARCHLIGHT SECTION** on page 286 is an excellent guide to sources of **USED EQUIPMENT** and other special services.

PROFESSIONAL SERVICES, including **CONSULTANTS,** are advertised on page 285. The experts listed can solve many of your difficult problems.

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These mechanical properties give USS "T-1" Steel its amazing versatility and ability to cut costs

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USS Carilloy "T-1" Steel can be furnished to the following heat-treated mechanical properties:

Plate Thickness:	¼" to 2" incl.	Over 2" to 4" incl.	Over 4" to 6" incl.
Yield Strength, Ext. under load (min)	90,000 psi	90,000 psi	90,000 psi
Tensile Strength (min)	105,000 psi	105,000 psi	105,000 psi
Elongation in 2", % (min)	18	17	16
Reduction of Area,% (min)	55*	50	45

* A standard .505" round tensile specimen is used if the thickness exceeds ¾". On sizes ¾" and under, a strap-type tensile specimen may be used which necessitates a lowering of the Reduction of Area Specification to 45% minimum. All testing in accordance with ASTM recommended practices.

WELDING PROCEDURES

1 Use a low hydrogen-coated electrode. When such electrodes are used, welding may be performed without preheating with no hazard of underbead cracking. If cellulose-coated electrodes are used, they will probably cause underbead cracking.

2 Use AWS 12015 electrodes if 100% joint efficiency is necessary and if stress relieving is not going to be done. If stress relieving is necessary, the AWS 12015 rod must not be used, because the weld metal deposited by this rod, even though strong and safe in the "as-welded" condition, becomes embrittled when stress-relieved.

3 Use an AWS 9015 electrode of the manganese-molybdenum type when welding must be followed by stress relieving. This rod deposits weld metal which will not develop the full strength of the base metal, so 100% joint efficiency will not usually be obtained. With properly designed joints, an efficiency of 90% may be realized. Stress relieving of weldments made of USS "T-1" Steel is not generally considered necessary, because such weldments are tough in the "as-welded" conditions. Stress relieving may be necessary under certain conditions in which stress corrosion is involved or where dimensional stability during machining is a factor. Stress relieving temperatures should not exceed 1150°F.

4 Some fabricators have reported good results with AWS 11016 electrodes, achieving good joint efficiency after stress relieving.

5 A limited amount of work has been done on the automatic welding of "T-1" Steel. One method appears to be satisfactory and is in use by a major customer.

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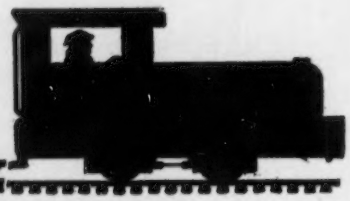

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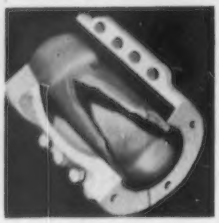

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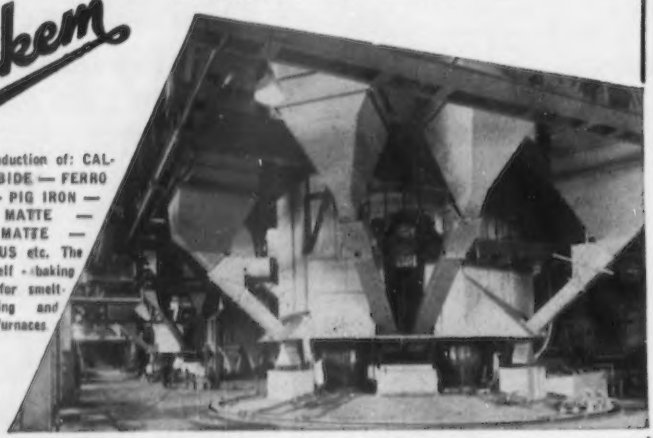

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2—8 ton General Electric, 36" ga.
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1—Fagregren Single Cell
1—#15 Denver Sub-A 4 cell
1—Denver 4 cell, 22 x 27
1—Denver 8 cell, 22 x 27
1—Morse-Weinig 2 cell, 37 x 37

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3—Eimco Model 12B Loaders
4—Eimco Model 21 Loaders
3—Joy 5B4 Loaders

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5—2¼" x 3½" new Morse lab crusher
4—4" x 6" new Morse lab crusher
1—7" x 12" Universal
1—9" x 15" Farrell
1—8" x 24" Rogers
1—13" x 24" Farrell

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4—Ingersoll-Rand Model D6U
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7—Gardner-Denver Model HIT
1—Sullivan Model L-111
2—Joy "Turbinair" Model F-113
1—Gardner-Denver Model HM

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1—5 HP Sullivan Tugger, Type DE
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1—15 HP Joy 2 drum Slusher, Model AAF-212
1—15 HP Joy 2 drum Slusher, Model AF-212
1—10 HP Sullivan 3 drum Slusher, Model HDE-10
1—10 HP Sullivan 2 drum Slusher, Model HD-10-B, driven by Continental gas engine

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1—30 HP Vulcan
1—37 HP Hoist
1—40 HP Hendrie & Bolthoff
2—50 HP Vulcan, #4½
1—75 HP Vulcan
4—100 HP Box
1—112 HP Vulcan
2—125 HP Ottumwa
2—150 HP Vulcan

HOISTS—DOUBLE DRUM

1—15 HP Byers
1—22 HP Vulcan, #11½
1—52 HP Minneapolis
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1—40 HP American
1—80 HP Lidgerwood
1—80 HP Clyde

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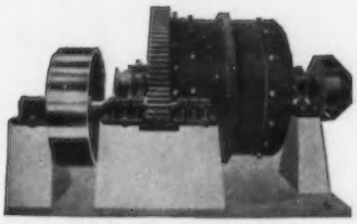

1—4' x 4' Marcy Ball Mill
1—4' x 4' Denver Ball Mill
1—6' x 48" Hardinge Conical Ball Mill
1—8' x 22" Hardinge Conical Pebble Mill
1—3' x 8' Marcy Rod Mill

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1—198 CFM Sullivan, 10" & 5¾" x 5"
1—293 CFM Ingersoll-Rand, 12" & 6" x 10"
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1—447 CFM Ingersoll-Rand, 14" & 7½" x 12"
1—637 CFM Sullivan, 14" & 8¾" x 10"
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1—800 CFM Ingersoll-Rand, 18" & 11" x 16"

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3—Joy Axivane Blowers, 5 HP
1—Sutorbilt 7L Rotary Blower
1—Sutorbilt #12-30 Rotary Blower
1—16" x 48" Connersville Rotary Blower
1—8H-42" Jeffrey Aerodyne Fan
1—7' Jeffrey Aerovane Fan
1—10" Joy La-Del Axial Flow Fan

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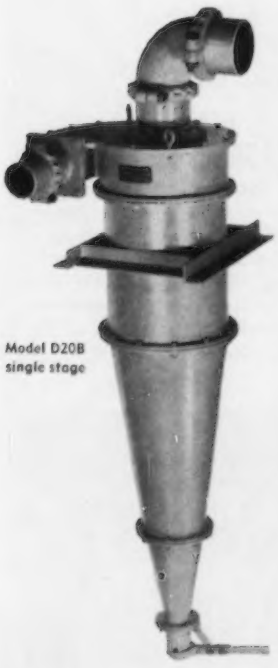

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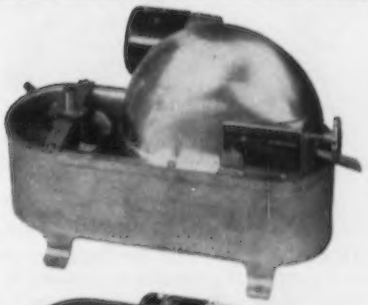

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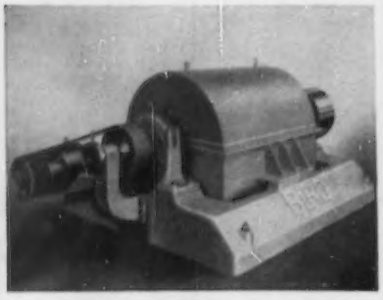

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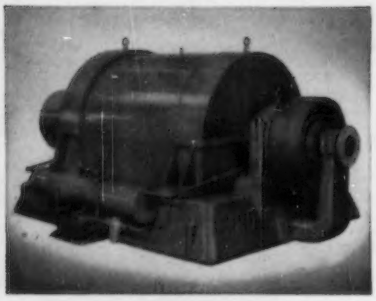

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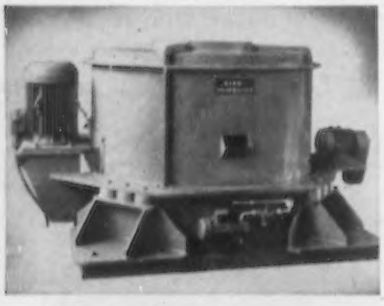

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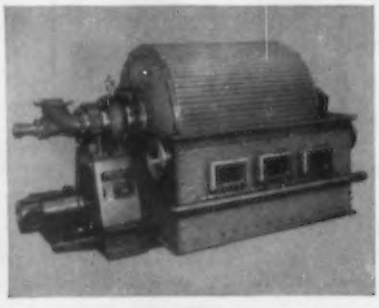

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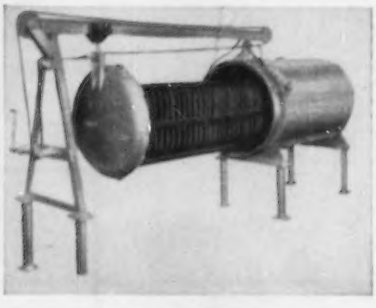

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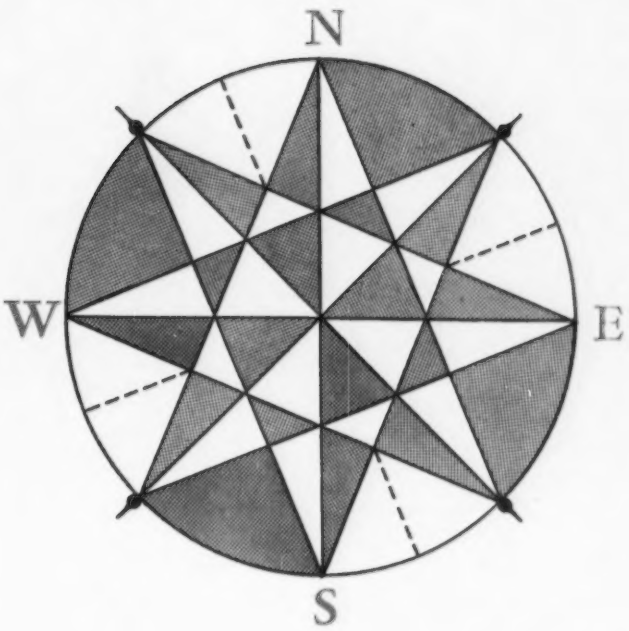

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